BLACK, WHITE, OR GREEN? THE EFFECTS OF RACIAL COMPOSITION AND SOCIOECONOMIC STATUS ON NEIGHBORHOOD-LEVEL TOBACCO OUTLET DENSITY IN MARYLAND

By

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A dissertation submitted to Johns Hopkins University in conformity with the requirements for the degree of Doctor of Philosophy

Baltimore, Maryland

October 2017

Abstract

Despite declines in tobacco use, disparities in tobacco-related health outcomes continue to affect disadvantaged populations such as Blacks and low-income individuals. Efforts have been made to reduce tobacco use, but it is important to consider the influence of tobacco outlet density. The research of the relationship between sociodemographics and tobacco outlet density is limited, but studies have reported associations that warrant deeper investigation. This study utilized the contextual-ecological heterogeneity of Maryland to elucidate the relationship between race and socioeconomic status to refine the basic epidemiological foundation of determinants of tobacco outlet density. Data included Census Tract-level sociodemographic data from the 2011-2015 American Community Survey, Maryland roadway data, and 2016-2017 Maryland tobacco outlet addresses. Tobacco outlet density was measured as both the number of tobacco outlets per 1,000 persons per Census Tract and the number of tobacco outlets per 10km of roadway. Two-sample t-tests were conducted to compare mean descriptives across jurisdictions, and spatial lag regression models were conducted to determine the direct association of sociodemographics and place with tobacco outlet density. Aim I investigated the relationship between socioeconomic status and tobacco outlet density in predominantly White Maryland counties. The results of the study supported the hypothesis, showing that predominantly-White counties with higher socioeconomic status had lower tobacco outlet density than predominantly-White counties with lower socioeconomic status. Aim II examined the relationship between racial composition and tobacco outlet density while controlling for socioeconomic status and urbanicity in Maryland counties. The results did not support the hypothesis, as predominantly-White counties had lower tobacco outlet density than predominantly-Black counties, despite both having similar socioeconomic status. Aim III was a descriptive epidemiological study of the relationship

between sociodemographics and tobacco outlet density in Maryland. The results of the findings were consistent with findings from past statewide and nationwide tobacco outlet density studies, showing that Black population percentage was directly related to tobacco outlet density, White population percentage was inversely related to tobacco outlet density, and that socioeconomic status was inversely related to tobacco outlet density. The overall findings support the existence of racial and socioeconomic gradients that must be acknowledged in tobacco control policies.

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Acknowledgments

I acknowledge the Creator of all things who goes by many names. God. Allah. Jehovah. Jesus Christ. Olodumare. Jah. Regardless of title, it is the Spirit of Love that has carried me to this point and will carry me to many more along my journey of life. I only ask that You continue guiding me in exuding love in all that I do, for as long as I am blessed to do it.

I acknowledge all those who have helped me along this process, which began in Summer 2008. To Dr. Yamalis Diaz, who saw something in me that I did not see in myself, you were the catalyst for this journey and I thank you. To Project L/EARN at Rutgers University – Deedee, Dr. Miller, Dr. Guarnaccia, Dawne, Theresa, Ms. Applegate, Datrell, Ayana and my cohort – thank you for instilling in this young Black man the foundation for social science research. To Dr. Andrew Peterson, thank you for introducing me to the world of tobacco outlet density and showing me the relevance to my life experience.

To the professors and researchers who met with me and provided me insight and guidance as I decided my graduate school future, I am grateful to you all. To "double" Dr. Adam Milam, thank you for being my big brother throughout this journey and a constant source of reassurance. To Dr. Debra Furr-Holden, who told me what I needed to do and then allowed me to do it: there are not enough words to express my gratitude. You not only pushed me as a researcher but as a person. I will never forget your support as I began my life as a doctoral student, and as a father. To the staff of the Mental Health department – Ms. Patty, Ms. Sherrie, Ms. Linda, Ms. Michelle, Candice, Carlina, Ryan, Scott and Sam – and all the staff at Hampton House including maintenance and security: you all are the unsung heroes and sheroes and deserve all the praise in the world. This is just my little way of saying thanks.

Finally, I thank my thesis committee – my advisor Dr. Phil Leaf, Dr. Furr-Holden, Dr. Roland Thorpe and Dr. Frank Curriero – as well as my dissertation committee – Dr. Leaf, Dr. Darrell Gaskin, Dr. Thorpe and Dr. Joe Gallo. Thank you for your expertise, your encouragement, your guidance and your appreciation of the research I conducted. This is a journey I will remember for the rest of my life.

Dedication

I dedicate this dissertation to the millions of Africans who were stolen from their homelands, enslaved against their will, transported to a new world, and forced to be the unrecognized backbone of the United States of America. Despite murder, despite rape, despite displacement, despite torture and despite no dignity given…they survived. Because they survived, I am here. Because I am here, I will always fight for them and for their true legacy.

I dedicate this dissertation to the ancestors that continue to watch over me. My paternal grandfather for whom I am named, David Olawuyi Fakunle. My maternal grandparents, Lonnie Pierce, Sr. and Mary Lee Pierce. My great-uncle Jesse "Booker" Williams. My godfather, Dr. Elmer Martin, who along with my godmother Dr. Joanne Martin assured that I would forever live my life emancipated from the lie of Black inferiority. Mama Mary Carter Smith, who taught me the art of African storytelling. My friends like Ms. Tammy, Mr. Kenny and all those who reminded me to remain humble and committed to the people I represent and love. I pray that you continue to watch over me, for I will always need your guidance.

I dedicate this dissertation to my parents, Taiwo Fakunle and Deborah Pierce-Fakunle. I love you more than I could ever express, but hopefully this helps. To my fiancée Doralee, thank you for making me whole again. I look forward to continuing to build our life together. To my son, Cruz-Matisse: you will <u>always</u> be my greatest accomplishment. No matter what you do or where you go, Daddy will always love you. Thank you for helping me begin a new life, one with you.

Finally, I dedicate this dissertation to the people of Baltimore. Baltimore is my city, my home. I recognize that it faces challenges, and many are a result of this city's history of institutional racism. That is why I choose to stay: there is too much work to be done. I dedicate my career and my life to helping undo the generations of oppression suffered by Baltimore's people, and to be a

vessel for the elevation of all people in this city to the highest levels of their abilities and aspirations.

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"They ask me what I'm writin' for,
I'm writin' to show you what we fightin' for."

-Talib Kweli, "The Blast"

Chapter 1: Introduction

The Centers for Disease Control and Prevention charted U.S. adult smoking rates between 1965 and 2014, and the results showed a decrease from 42.4% to 16.8% (CDC, 2016). A more time-refined investigation of U.S. adult smoking rates reported a 17.1% decrease in smoking rate among Blacks and an 11.3% decrease in smoking rate among respondents reporting a family income below the poverty line between 2005 and 2014 (Jamal et. al, 2015). However, populations with a history of disadvantage in the United States – specifically Blacks and low-income people – experience adverse health outcomes due to cigarette smoking and tobacco use at disproportionately higher rates. The CDC, the U.S. Department of Health and Human Services (HHS) and organizations such as the American Lung Association continue to report racial and socioeconomic disparities in tobacco-related health outcomes. While Blacks tend to initiate tobacco use later in life and smoke fewer cigarettes than Whites, Blacks are more likely to die from smoking-related diseases than Whites (CDC, 2015). Similarly, people with a lower income are more likely to suffer from smoking-related diseases than people with a higher income (CDC, 2015). Additionally, people with a lower income smoke more heavily than people with a higher income (CDC, 2015). While lower-income people and Blacks are as likely and more likely, respectively, to attempt quitting smoking than their socioeconomic and racial counterparts, both groups are less likely to succeed in quitting (HHS, 2014; Campaign for Tobacco-Free Kids, 2015). Taxation of products, policies banning public use, stringent monitoring of youth access, and awareness initiatives are major mechanisms that are used to reduce smoking and tobacco use (CDC, 2000). HHS currently has a national media campaign, “Tips from Former Smokers,” that highlights various people who deal with, have dealt with, or have died due to complications related to their tobacco use or exposure to tobacco use. Another HHS campaign, “The Real

Cost," focuses on health consequences associated with tobacco use by youth (HHS, 2017). The "truth" campaign, a nationwide anti-tobacco campaign funded and produced by the American Legacy Foundation, has recently aired commercials highlighting the disproportionate number of tobacco advertisements found in low-income, predominantly Black neighborhoods (truth, 2017). Additionally, many local and state municipalities have banned tobacco use in indoor and outdoor public areas and establishments such as restaurants, bars and government buildings (HHS, 2017). Disparate health outcomes associated with tobacco use persist among Black and lower-income populations despite targeted anti-tobacco use campaigns, policies that have restricted tobacco use, and financial deterrents from tobacco use such as taxes (Peterson et. al, 1992; Chaloupka et. al, 2002; Campaign for Tobacco-Free Kids, 2017). Therefore, an important line of inquiry to consider is the availability and access to tobacco products. Tobacco outlet density is the epidemiology of the availability and access to tobacco products and retailers in a locale. A question raised within tobacco outlet density research was whether differences in racial concentration, specifically Blacks and Whites, and differences in socioeconomic status were associated with differences in tobacco outlet density. Research that has investigated the association between sociodemographics and tobacco outlet density is limited relative to research that has investigated the relationship between availability, access and use. Some studies have reported consistent patterns between race, socioeconomic status, and tobacco outlet density, specifically that higher tobacco outlet density is found among predominantly Black and predominantly lower-income areas (Peterson et. al, 2005; Schneider et. al, 2005; Fakunle et. al, 2010). Fewer studies have examined and reported direct the direct effects of sociodemographics on tobacco outlet density, but those studies have consistently reported a direct association between Black population percentage and tobacco outlet density and an inverse association

between income and tobacco outlet density (Fakunle et. al, 2016; Lee et. al, 2017). Additionally, the results reported by some studies could be questioned based on the racial and/or socioeconomic homogeneity of the investigated areas (Peterson et. al, 2005; Schneider et. al, 2005; Fakunle et. al, 2010). The state of Maryland provided a rich ecological-contextual heterogeneity of racial concentration and socioeconomic status, meaning that there were natural interactions of place, race and socioeconomic status on a macro-level scale that allowed for comparisons of racial and socioeconomic profiles without a need to manipulate the data. Additionally, examination of Maryland allowed for continuing first steps in understanding how race and socioeconomic differences impact the availability and access to tobacco products.

The overall goal of this study is to elucidate the relationship between race, socioeconomic status, and tobacco outlet density, thereby refining the basic epidemiological foundation of social determinants of tobacco availability and access. This study will facilitate an understanding of the relationships and support the development of policies that can reduce the disadvantage created by inequitable tobacco availability and access, while pushing tobacco researchers towards nuanced understandings of the causal factors of differences in tobacco outlet density. Research on tobacco availability and access shares similarities with research on alcohol availability and access, but there are differences in how findings and interpretations have been applied. Alcohol research has shown that stringent policies that restrict availability and access of alcohol products to vulnerable populations (such as youth) can and have led to reductions in alcohol use and behaviors associated with excessive alcohol use (Campbell et. al, 2009; Jennings et. al, 2014; Milam et. al, 2014; Livingston, 2008). Like alcohol outlet density research, tobacco outlet density research has linked availability and access to tobacco use, including earlier initiation and more difficult cessation. Additionally, a common recommendation after many tobacco outlet

density studies is that policies be enacted to reduce tobacco outlet availability and access (Reitzel et. al, 2011; Novak et. al, 2006; Lipperman-Kreda et. al, 2012). Ashe and colleagues (2003) argued that the threshold needed to convince lawmakers to reduce availability and access to tobacco via "police power" is lower than that of alcohol. However, many local and state municipalities are slow to utilize their full legislative ability to reduce tobacco outlet density despite evidence that constitutional challenges would not be a major issue, and despite evidence that shows reduction in tobacco outlet density does lead to reductions in smoking (Cohen & Anglin, 2009; Luke et. al, 2016; Ackerman et. al, 2017; Ribisl et. al, 2017; Polinski et. al, 2017). San Francisco ambitiously passed the Tobacco Sales Reduction Act in 2014 which will reduce the number of tobacco outlets licenses to a maximum of 45 per district (11 districts total) over the next 10-15 years. It would equate to 495 tobacco outlets for a city which is currently at a population of about 850,000 people, or approximately 0.6 outlets per 1,000 persons. Existing tobacco licenses would not be re-issued once the outlet closed, utilizing attrition to drive the reduction. Additionally, any new tobacco outlets must be at least 500 feet from schools and other tobacco outlets (Sabatini, 2014). Given the existing disparities in both tobacco use and subsequent maladies resulting from use, it would be beneficial to enact licensing and zoning regulations considerate of socioeconomically disadvantaged populations, and San Francisco has implemented a potentially replicable model by which to reduce tobacco availability and catalyze equitable health outcomes. The conceptual framework for this dissertation is the social determinants of health, as first conceived by Marmot and colleagues (1991) in their publication of the Whitehall II study. In the paper, they reported a significant relationship between the hierarchal employment status of British civil servants and self-reported health and behavioral outcomes, and since that time it has become the model for understanding how the environment –

be it natural, physical, social, or cultural – impacts the psychosocial health, behavior and wellbeing of its inhabitants (Williams & Collins, 1995; Robinette et. al, 2017; Massey et. al, 1987). The built environment is defined in part as the physical (i.e., man-made) organization of areas where individuals live and work, including homes, buildings, streets, open spaces, and infrastructure (Purdue et. al, 2003; Renalds et. al, 2010). The detrimental effects that built environments have on disadvantaged populations have been widely researched, such as health disparities caused by an abundance of fast-food restaurants and alcohol outlets, coupled with a lack of green spaces and safe areas for physical activity in lower-income neighborhoods (Walker et. al, 2010; LaVeist et. al, 2000; Berke et. al, 2010; Dai, 2011; Gordon-Larsen et. al, 2006). Similarly, the benefits of sustainable built environments also have been reported (Srinivasan et. al, 2003). Social determinants show that adverse health outcomes can be due to the cumulative impact of an oversaturation of specific entities that suppress health and wellbeing, a deficiency in specific entities that promote health and wellbeing, and the overarching damage caused by stress associated with racism, poverty and disadvantage (Evans et. al, 2007; Boardman et. al, 2001; Morello-Frosch et. al, 2006). For example, LaVeist and Wallace (2000) found disproportionately higher numbers of liquor stores located within predominantly Black Census Tracts in Baltimore, despite controlling for socioeconomic status, and that lower-income, predominantly Black Census Tracts had more liquors stores per capita than others. Additionally, their study found significant associations between liquor store availability and health-related issues. Similarly, Berke and colleagues (2010) reported greater alcohol outlet density in Census Tracts with higher proportions of Blacks and Hispanic/Latinos. In addition to social determinants of health, this study was influenced by the Exploring Health Disparities in Integrated Communities (EHDIC) study, led by Thomas LaVeist and colleagues, which is one of the more well-regarded studies on

place-based disparities (LaVeist, 2005; LaVeist et. al, 2011; White et. al, 2012). The study aimed to disentangle the relationship between race, socioeconomic status and health outcomes, with a focus on acknowledging the structural forces that have facilitated inequalities in availability and access to health resources, such as segregation. A major conclusion of the study is that policies designed to reduce health disparities must consider the varying degrees of societal resources in neighborhoods, and not just racial differences and behavior change (LaVeist et. al, 2011). Like the EHDIC study and other studies that aimed to elucidate the complex relationship of race and socioeconomic status in the United States, this study aimed to disentangle the relationship between race, socioeconomic status and the availability and access to tobacco products via outlets, with the goal of elaborating on the influence of place and its characteristics on tobacco outlet density (LaVeist et. al, 2007). Tobacco outlet density is a direct measure of an aspect of the built environment – availability and access to tobacco products – and one that carries significant weight due to tremendous harm caused by tobacco use (Polinski et. al, 2017).

The state of Maryland has a rich ecological-contextual sociodemographic heterogeneity, which presented a unique to naturally observe the contextual interaction of race and socioeconomic status within and across locales. Additionally, Maryland illustrates of the importance of acknowledging and examining how place and the dynamics within place influence health outcomes and the structural components, like tobacco availability and access, which may lead to disparate health outcomes. Specifically, Maryland is the wealthiest state in the United States, yet exhibits stark health outcome disparities that can be found among racial and socioeconomic lines (U.S Census Bureau, 2017). For example, according to the Maryland Department of Health's (then the Maryland Department of Health and Mental Hygiene) Office of Minority Health and Health Disparities (2012), the 2007-2009 age adjusted heart disease

mortality rates for Whites in the Western Maryland region (Allegany, Garrett and Washington counties) were not only higher than that of Whites across the entire state, but were comparable and in some cases higher than the mortality rates of Blacks across the entire state. Similar patterns were found with Emergency Department visits due to diabetes, a health outcome like heart disease that has been linked to chronic tobacco use. While in those cases the rates for Whites in Western Maryland were lower than Blacks across Maryland, the rates were consistently higher than Whites across Maryland. Between 2007 and 2009, the average median household income for Western Maryland, a predominantly-White region, was lower ($48,164) than Maryland's statewide median household income ($69,695).

This dissertation is structured into three manuscripts, with each manuscript addressing the three specific aims. The first aim was to examine the relationship between socioeconomic status and tobacco outlet density while controlling for White population percentage in predominantly White Maryland jurisdictions. The hypothesis was that jurisdictions with similar, predominantly White populations will exhibit an inverse relationship between socioeconomic status and tobacco outlet density. This hypothesis was supported by previous work that found an inverse relationship between socioeconomic status and tobacco outlet density in non-White areas, and this study aimed to show that the relationship was not a racial phenomenon. The second aim was to examine the relationship between racial concentration (Black/White) and tobacco outlet density, while accounting for socioeconomic status and urbanicity in Maryland jurisdictions. The hypothesis was that jurisdictions will show no relationship between racial concentration – Black and/or White – and tobacco outlet density because of the similar socioeconomic status. This hypothesis was supported by work that reported median household income as the most consistent predictor of tobacco outlet density while controlling for racial population percentages. The third

aim was to examine the relationship between sociodemographics and tobacco outlet density in Maryland via a descriptive epidemiological study, while using two outcome measures of tobacco outlet density – one measure to address availability and one measure to address access. Maryland was selected as the study area for the three aims due to its rich ecological-contextual racial and socioeconomic heterogeneity, which allowed for the observation of contextual interaction of race and socioeconomic status on tobacco outlet density within and across locales (See Appendix A). Consistent with Fakunle and colleagues' prior study of the state (2016), counties and regions within Maryland were selected based on their ability to highlight contextual interactions of race and socioeconomic status, as determined by their racial concentration and median household income, and this study aimed to show consistencies in the relationships with tobacco outlet density across multiple jurisdictions.

Census Tract demographic data were obtained from the 2011-2015 American Community Survey (ACS), made available via the United States Census website. The American Community Survey, inaugurated in 2005, is a perennial survey administered by the U.S. Census Bureau that acquires data on the sociodemographic dynamics of people living in the United States (U.S. Census Bureau, 2016). The five-year pooled estimate of sociodemographic data was preferred over the one-year and three-year pooled estimates because of the larger dataset that included data for all areas, thus allowing for examination of small Residential Census Tracts, and greater reliability. Of the 1,406 Census Tracts in Maryland, 18 had a total population of less than 600 persons and consistent with the methodology from Fakunle et. al (2016) were excluded from analyses. The exclusion resulted in a final total of 1,388 included in the analyses. Maryland tobacco outlet data – including retailer names, contact information and retail/mailing locations – were obtained from the Maryland State Licensing Bureau, which provided the addresses for

retailers with an active Cigarette, Special Cigarette, Other Tobacco Product (OTP) or Tobacconist licenses as of April 30, 2017. The sale of loose cigarettes in prohibited by Maryland state law, although licensed retailers may engage in the activity (Smith et. al, 2007). Tobacco outlet retail addresses were geocoded via MD iMap – the State of Maryland's Mapping and GIS Data Portal – the most current publicly available geocoding service for the state. Of the addresses provided (n = 2,851), only five needed to be modified: one determined to be a duplicate (deleted), one determined to be out-of-state (Florida) with no alternative address given (deleted), one determined to have two adjacent addresses (second address added), one determined to be closed (deleted), and one geocoded with the mailing address due to the outlet being a food truck. Most of the licensed tobacco outlets were successfully geocoded after the first iteration. Of the revised total addresses (n = 2,849), all but 144 were successfully geocoded via the Batch Address Look-Up service. The 144 entries that did not return a geocode were cross-referenced with Google Maps and other internet-based resources (e.g., retailer websites) to verify the correct address. After verification, the addresses were re-run via the Single Address Look-Up service of which all but 19 were successfully geocoded. In total, 2,830 of the 2,849 addresses (99.3%) were successfully geocoded. The addresses were then merged with Maryland sociodemographic data via the Spatial Join tool in ArcGIS. It was then determined that a total of 3 tobacco outlets were located among the 18 Census Tracts excluded from analyses. Eight variables measuring racial composition, socioeconomic status and built environment were selected from the ACS dataset. The expansion of socioeconomic covariates beyond the study of two predominantly-Black locales in Maryland by Fakunle and colleagues (2016) was to provide a more thorough understanding of the relationship between socioeconomic status, race and tobacco outlet density beyond one measure – median household income (Mayers et. al, 2012; Rodriguez et. al, 2012;

Lee et. al, 2017). Additionally, the expansion of socioeconomic covariates aimed to address the lack of consideration in research for income inequality's influence in health disparities (Kawachi & Kennedy, 1999; Subramanian & Kawachi, 2004; Fakunle et. al, 2010). The measures included in the study were the total population, the total number of individuals who identify as Black or African American (converted to a percentage), the total number of individuals who identify as White (converted to a percentage), the percentage of individuals 25 years and over who have obtained at least a Bachelor's degree, the Gini index of income inequality (presented as a coefficient), the total number of vacant housing units, the total number of individuals 16 years and older who are actively in the labor force (converted to a percentage), and median household income, expressed in 2015 inflation-adjusted dollars. Residential Census Tracts have been the prevailing spatial unit of measurement in tobacco outlet density research, yet other spatial units have been utilized in tobacco outlet density studies such as census block groups, which are smaller and more refined than Residential Census Tracts (Reid et. al, 2005; Ogneva-Himmelberger et. al, 2010). Similar research in alcohol outlet density have also used census block groups as the spatial unit of measurement (Gorman et. al, 2001; Morrison et. al, 2016; Grubesic et. al, 2016). While there is no consensus unit of measurement, Residential Census Tracts are the most frequently used. Census block groups, while more refined than Residential Census Tracts, have more variation which can lead to analytical instability. Likewise, analyses of broad jurisdictions like cities, counties or states may lead to results that do not allow for inference (Yu et. al, 2010). Therefore, Residential Census Tracts are currently the best spatial units that both exude distinct neighborhood characteristics yet provide manageable data and potentially generalizable analysis results. The choice of a measure for tobacco outlet density usually been at the discretion of the researcher, and may reflect no more than their interest in

either availability or access, or the dynamics of the study area such as levels of urbanicity (Schneider et. al, 2005; Reid et. al, 2005; Fakunle et. al, 2010; Fakunle et. al, 2016). To account for differences in urbanicity in Maryland, two measures of tobacco outlet density were utilized – one to measure availability of tobacco outlets and one to measure access to tobacco outlets. Consistent with Fakunle et. al (2016) and their investigation of predominantly Black Maryland counties, this study will measure tobacco availability as the number of tobacco outlets per 1,000 persons per Residential Census Tract. Using outlets per 1,000 persons rather than the number of outlets in the individual Residential Census Tracts accounts for the likelihood that residential census tracts with a greater population will likely have a greater number of tobacco outlets in its vicinity. Operationalizing outlet density based on population is used to measure the availability of alcohol (Berke et. al, 2010; Zhu et. al, 2004). Tobacco access was measured as the number of tobacco outlets per 10km of roadway, consistent with past tobacco outlet density studies (Schneider et. al, 2005; Fakunle et. al, 2010; Peterson et. al, 2011; Reid et. al, 2013)

For Aims I and II of this study, two-sample t-tests were conducted to compare the mean values per Census Tract of the study areas and provide a baseline measure of differences in tobacco outlet density and sociodemographic characteristics across areas. The two-sample t-tests were conducted via the SPSS statistical package. For all three aims of the study, spatial lag Poisson models were conducted to show the individual and collective effects of the sociodemographic covariates on tobacco outlet density both within and across jurisdictions. For Aims I and II, jurisdictions that were compared to each other in the two-sample t-tests were then compared to each other in place-based interaction Poisson models. These were conducted to determine if there were differences in the magnitude of relationship between covariates and tobacco outlet density based on location. The covariates were spatially lagged, meaning that the

models included coefficients for the covariate in the immediate, proximal Census Tracts (focal effects) and the extended, distal environment around Census Tracts (spatial lag effects). To conduct spatial analyses of social factors and tobacco outlet density, neighborhood structures were created. In spatial statistics, a neighborhood structure is an arrangement of spatial data and in this study, an arrangement of tobacco outlet and sociodemographic data (Fischer & Gettis, 2013). For this analysis and to best adjust for spatial dependence, a "neighborhood" was defined as a Census Tract that shared at least more than one boundary with another Census Tract. Weight matrices – quantified representations of spatial relationships – were then created based on the neighborhood structures. The Census Tracts and sociodemographics data for each Tract provided the features needed to create the matrices. After the creation of the weight matrices, spatial smoothing was conducted to assure more consistent outcomes tobacco outlet density measures across the established Census Tracts. Spatial smoothing is a technique that aggregated the sociodemographic and tobacco outlet data across polygons (Census Tracts) to create more robust estimates and improve accuracy (Auchincloss et. al, 2012). The spatial smoothing was based on population, so areas with a higher population were weighted more heavily than area with a lower population. After spatial smoothing, Moran's I was tested to determine whether jurisdictions exhibited spatial dependence. Moran's I is a correlation coefficient, ranging from -1 to 1, that measures the extent of spatial dependence. A coefficient closer to 1 indicates similarity between adjacent areas, a coefficient closer to -1 indicates dissimilarity between adjacent areas, and a coefficient closer to zero indicates no correlation between adjacent areas (Statistics How To, 2017. All spatial analyses were conducted via the RStudio software package. Four models were conducted for each study area: a univariate model for each covariate, a multivariate model for focal effect covariates, a multivariate model for focal effect and spatially lagged covariates, and a

multivariate model for focal effect and spatially lagged covariates, and interaction terms between the focal effect and spatially lagged covariates. Exponentiated beta coefficients were reported and magnified for easier interpretation. Due to the high number of significant coefficients in the models, the results section highlights focal effect and/or spatially lagged covariates that exhibited a consistent relationship (direct or inverse) across all four models. Chi-square statistics were conducted to determine the extent of overdispersion, or presence of greater variability, in the final model compared to the null model. Overdispersion occurs when the observed variance is greater than the theoretical variance, which is tied to the mean in Poisson models, and this indicates how much the models explain the variance of tobacco outlet density. The higher or lower the chi-square statistic, the more or less data are overdispersed.

Chapter 2: Literature Review of Tobacco Outlet Density Research

Tobacco outlet density research is a relatively new branch of drug epidemiology, with the first prominent study published by Hyland et. al (2003), reporting increases in outlets per 10km of roadway across increasing quartiles of Black population percentage and decreases in outlets per 10km of roadway across increasing quartiles of median household income. Tobacco outlet density is an assessment of the physical and geographic availability of tobacco products and retailers in each locale. As with alcohol outlet density (Campbell et. al, 2009; Jennings et. al, 2014; Milam et. al, 2014; Livingston, 2008), tobacco outlet density measures a macro-level exposure (i.e., availability and access to tobacco outlets), and studies investigate how the exposure may relate to micro-level behavior such as smoking (Novak et. al, 2006; Reitzel et. al, 2011; Cantrell et. al, 2015) or how population dynamics impact the exposure (Peterson et. al, 2005; Fakunle et. al, 2010; Reid et. al, 2005). By analyzing tobacco retailer data, which can include location, products sold and revenue, mapped onto Census tracts – statistical subdivisions of municipalities that are either residential or commercial – researchers have been able to quantify tobacco outlet density in cities, counties, states and provinces, thus exemplifying the extent of individuals' exposure to tobacco products based on both availability of outlets within a locale and a person's access to outlets within a locale (Laws et. al, 2002; Hyland et. al, 2003; Peterson et. al, 2005). Preceding a focus on the availability and access to tobacco outlets, researchers investigated the influence of tobacco advertising and racial differences in marketing, concluding that significantly more tobacco advertising was found in non-White, lower income locales (Cummings et. al, 1987; Barbeau et. al, 2005; Luke et. al, 2009). There has been attention on the relationship between tobacco outlet density and youth smoking behavior,

concluding that there is a positive relationship between tobacco outlet density and youth smoking prevalence, as well as associations with earlier tobacco use initiation and increased difficulty with smoking cessation (Novak et. al, 2006; Henriksen et. al, 2008; Cantrell et. al, 2015; Lipperman-Kreda et. al, 2012; McCarthy et. al, 2009). The association between outlet density and behavioral outcomes bears resemblance to alcohol outlet density research, which has studies that have examined relationships between the availability of alcohol outlets and micro-level behaviors such as alcohol use (both youth and adult), violence, and motor vehicle accidents; those studies reported higher levels of alcohol use, violence associated with excessive alcohol use, and motor vehicle accidents (Parker et. al, 1978; Colon, 1982; Scribner et. al, 1998; Kypri et. al, 2008; Chen et. al, 2010). Therefore, tobacco outlet density can be considered a public health concern that warrants more research and more proactive policy resulting from the research (Ashe et. al, 2003; Cohen & Anglin, 2009). Research on the effects and influence of sociodemographics, particularly those on the neighborhood level, is field within tobacco outlet density that emerged from studies on tobacco advertising (Cummings et. al, 1987; Barbeau et. al, 2005; Luke et. al, 2009), and began with the earliest studies on tobacco outlet density (Laws et. al, 2002; Hyland et. al, 2003; Peterson et. al, 2005). Early tobacco outlet density studies examined the association of outlet density with population demographics, specifically Blacks and Hispanic/Latinos, reporting patterns of higher tobacco outlet density in neighborhoods with higher concentrations of Blacks and Hispanic/Latinos (Peterson et. al, 2005; Schneider et. al, 2005; Fakunle et. al, 2010). There remains limited research on the relationship between sociodemographics and tobacco outlet density, and while a recent study was conducted with expanded sociodemographic considerations (Lee et. al, 2017) there remains a stagnation on the

investigation of race beyond Blacks and Hispanic/Latinos. Most research on tobacco outlet density continues to focus on the association with tobacco use, and findings from early tobacco outlet density-sociodemographics studies strongly suggested that higher concentrations of underrepresented racial and ethnic populations are associated with higher tobacco outlet density, yet there is very limited research that included White populations as a variable in the study of race and tobacco outlet density (Novak et. al, 2006; Lee et. al, 2017). Along with race, prior tobacco outlet density studies also focused on the influence of socioeconomic status on tobacco outlet density, reporting patterns of higher tobacco outlet density with neighborhoods with lower median household income (Hyland et. al, 2003; Peterson et. al, 2005; Schneider et. al, 2005; Fakunle et. al, 2010). However, the methodological approach was limited because it analyzed racial composition and median household income separately. Specifically, early studies utilized analyses of variance (ANOVAs) with median household income and Black/Latino population percentages divided into quartiles based on data from the study area(s). The results showed clear, significant patterns between the sociodemographic covariates and tobacco outlet density measures. However, the methodology did not establish direct correlations nor control for the selected covariates. Fakunle and colleagues (2010) utilized multivariable regression analyses of tobacco outlet density, in which socioeconomic status and race were adjusted in the same analytical model. The results the study, which included Black population percentage, Hispanic/Latino population percentage and median household income in two New Jersey counties selected based on total population, reported that median household income had a moderate inverse linear relationship with tobacco outlet density; meaning that as median household income increased, tobacco outlet density decreased, while controlling for two non-

White group populations. Furthermore, it suggested that socioeconomic status, for which median household income was the proxy, had a consistently strong linear relationship with tobacco outlet density when simultaneously examined with race, while race exhibited varying linear relationships with tobacco outlet density. Later tobacco outlet density studies have utilized regression as a primary analytical methodology (Yu et. al, 2010; Lipperman-Kreda et. al, 2012; Mayers et. al, 2012; Lee et. al, 2017) The Fakunle et. al (2010) study provided the some of the first evidence as to how socioeconomic dynamics contextually interact with racial composition regarding tobacco outlet density. As an advancement of the Fakunle (2010) study, this study aimed to supplement limited research which suggests that socioeconomic status exhibits a consistent relationship with tobacco outlet density regardless of race, including Whites, by demonstrating similar relationships that were reported among other racial groups such as Blacks (Fakunle et. al, 2016). The results of the findings may demonstrate that the availability and access to tobacco products via outlets is less determined by racial composition and more determined by socioeconomic status. Smoking is the leading cause of preventable death in the United States, and several of the leading causes of death in the United States are significantly correlated with tobacco use (HHS, 2014). The public health implications of race and socioeconomic status are also well known, as research showed the disparities in health outcomes based on each factor individually and collectively (Institute of Medicine (US) Committee on the Review and Assessment of the NIH's Strategic Research Plan and Budget to Reduce and Ultimately Eliminate Health Disparities, 2006). Tobacco use may cause and exacerbate many detrimental health outcomes such as lung disease, diabetes and birth defects (HHS, 2014; CDC, 2015), among individuals of lower socioeconomic status regardless of race or ethnicity, and

among individuals in various racial groups regardless of socioeconomic status (Barbeau et. al, 2004; Ward et. al, 2004; Trinidad et. al, 2011). The nuances of race and socioeconomic status in health disparities associated with tobacco use should also be researched in tobacco outlet density. While studies have investigated the influence of race and socioeconomic status on tobacco outlet density, Fakunle et. al (2016) began to parse out distinctions of socioeconomic status across racial similarity. This study continued that advancement, and began to parse out distinctions of racial composition across socioeconomic similarity. For example, are there similarities or differences in tobacco outlet density among White areas with different levels of socioeconomic status (investigated in Aim I)? Do lower-income areas have similar tobacco outlet density whether it is predominantly Black or predominantly White (investigated in Aim II)? To best understand the relationship involving complicated social constructs, the context of gradient should be included. Therefore, studies that adjust for race, socioeconomic status, and the varying magnitudes of the two, are essential to elucidate the associations. The connection between tobacco outlet density and tobacco use is clear: higher tobacco outlet density correlates with more tobacco use (McCarthy et. al, 2009; Shortt et. al, 2016; Cantrell et. al, 2015). However, there is opportunity for the trajectory of research on tobacco outlet density and population demographics to be altered and refined. Additionally, tobacco outlet density research can provide compelling evidence in support of initiating policy aimed at reducing tobacco availability (e.g., restricting tobacco retail licensing, reforming outlet zoning ordinances, etc.) in locales sensitive to price, physical access and health. Therefore, more conceptually and analytically sophisticated studies are imperative.

Chapter 3: The relationships between socioeconomic status and neighborhood-level tobacco outlet density in predominantly-White Maryland jurisdictions

Abstract

Introduction: Tobacco outlet density research has evolved to require both a more refined examination of socioeconomic status' influence on tobacco outlet density and a methodology that controls for spatial dependence. In tobacco outlet density research, median household income has long been the primary metric of socioeconomic status, but recent studies have heightened the importance of investigating the effects of other components of socioeconomic status such as income inequality, vacant housing and educational attainment. This study extends research conducted by Fakunle and colleagues, which found lower tobacco outlet density in predominantly-Black Maryland jurisdictions with higher SES, by analyzing the effects of socioeconomic status on Census-Tract level tobacco outlet density in five Maryland jurisdictions selected based on White population percentage and median household income. Methods: This study utilized tobacco outlet license data from the Maryland State Licensing Bureau, geocoded the addresses via the State of Maryland's Mapping and GIS Data Portal, and combined the addresses with 2011-2015 American Community Survey demographic data. Two-sample t-tests were conducted compare the mean values of sociodemographic variables and tobacco outlet density per Census Tract of the study areas, and spatial lag models were conducted to analyze the direct association between covariates and tobacco outlet density while accounting for spatial dependence between jurisdictions. Results: Two-sample t-tests results showed that jurisdictions with higher measures of socioeconomic status, despite similar White population percentages with their lower-SES counterparts, also had lower tobacco outlet density. However, areas with similar SES measures along with similar White population percentages had disparate tobacco outlet density outcomes. Spatial lag model results showed that median household income had

consistent associations with tobacco outlet density across most of the jurisdictions analyzed. Discussion: Results of this study corroborate the primary interpretation of Fakunle and colleagues (2016), in that differences in socioeconomic status among areas with similar racial concentrations correlate with differences in tobacco outlet density. Additionally, median household income appears to be the most consistent predictor of tobacco outlet density among socioeconomic status measures, when compared to income inequality, educational attainment, vacant housing, and other measures.

Introduction

Studying the influence of socioeconomic status on tobacco outlet density initially had been limited primarily to analyzing the relationship between median household income and tobacco outlet density, reporting that median household income exhibited patterns of lower tobacco outlet density in neighborhoods with higher median household income, and later an inverse linear relationship with tobacco outlet density (Peterson et. al, 2005; Fakunle et. al, 2010; Fakunle et. al, 2016; Lee et. al, 2017). However, more recent studies have included other components of socioeconomic status including education, employment and vacant housing (Mayers et. al, 2012; Lee et. al, 2017), reporting that they are also inversely related to tobacco outlet density. This has propelled researchers to suggest additional components within socioeconomic status that should be considered in the relation to tobacco outlet density in future research; the residual of the consideration discourages an overreliance on median household income. The interest in studying socioeconomic status' effects perhaps has correlated with greater availability of large, open-access datasets such as those provided by the United States Census Bureau and local and state authorities, although this cannot be confirmed (U.S. Census Bureau, 2016). Comprehensive investigation of socioeconomic status and tobacco outlet density

has also been benefitted by an advancing methodology, notably geocoding and spatial statistics such as spatial lag modeling (Yu et. al, 2009; Yu et. al, 2010; Fakunle et. al, 2016; Lee et. al, 2017). Spatial statistics involve techniques aimed at acknowledging and adjusting for characteristic similarities across proximal and distal physical locations (Ripley, 2005; Gelfand et. al, 2010). These similarities if left unaddressed can confound the relationships between covariates and tobacco outlet density by not determining whether the closeness of locales could potentially explain comparability in neighborhood dynamics. For example, without spatial analyses it could not be reported that the patterns of higher tobacco outlet density in neighborhoods with higher concentrations of Black and/or Hispanic/Latinos, as well as neighborhoods with lower median household income, could not be explained by the fact that some study areas were primarily occupied by Black and/or Hispanic/Latino, as well as low income, residents (Hyland et. al, 2003; Fakunle et. al, 2010; Yu et. al, 2009; Yu et. al, 2010). Spatial statistics gives researchers the ability to report findings of greater clarity as to what drives tobacco availability within socioeconomic status beyond median household income because of the ability to control for spatial dependence (Mayers et. al, 2012; Lee et. al, 2017). Spatial autocorrelation or spatial dependence, is a factor that has become a salient methodological development in tobacco outlet density research (Yu et. al, 2009; Yu et. al, 2010; Rodriguez et. al, 2012; Fakunle et. al, 2016; Lee et. al, 2017). Spatial autocorrelation is an occurrence in which areas closer together tend to be more similar than areas further apart. This correlation violates the assumption of independence, a major underpinning in research, which may render the assessment of associations with tobacco outlet density, which is based on physical and geographic availability and access, difficult to interpret because a major confounder – space – was not controlled. Recent research has utilized several techniques within spatial statistics to address

spatial autocorrelation and remove the space confounder, such as spatial lag modeling, spatial errors approach, fitting a covariance function to the errors using a distance matrix of unit centroids, and geographically weighted regression analyses; while the specific aims varied, they all determined that spatial autocorrelation was present in the study areas (Fakunle et. al, 2016; Loomis et. al, 2013; Rodriguez et. al, 2012; Yu et. al, 2009; Lee et. al, 2017). Spatial lag modeling, the methodology used for this study, can control for spatial autocorrelation by specifying what model components are to be lagged, be it the covariates included in the model, on the outcome in the model (auto-regressive), or both. Additionally, a spatial lag model can show the relationship between covariates and outcomes such as tobacco outlet density among the focal effects (i.e., effects operating at the area unit of analysis) and the neighborhood effects (i.e., effects defined through spatial lags to assess influence of the surrounding neighborhood). This can provide a more thorough understanding about how the dynamics of an area interact – be it in the same or opposite direction – in the immediate and distal space Regardless of the technique used, it is imperative that any future research involving tobacco outlet density include spatial methodologies that account for the potential violation of independence via spatial autocorrelation.

Previous research utilized the ecological-contextual heterogeneity of Maryland, via the American Community Survey (ACS) to investigate the relationship between socioeconomic status and tobacco outlet density within two predominantly-Black jurisdictions, and utilized matching as the primary modality for controlling confounders. The current study built on the work of the earlier study by utilizing the same technique with predominantly White jurisdictions in Maryland (Fakunle et. al, 2016). The aim was to determine how varying magnitudes of socioeconomic status metrics – median household income, educational attainment, employment

participation, etc. – correlate with tobacco outlet availability, and to measure the interactions among each other, within jurisdictions defined by a majority White population. The hypotheses were that jurisdictions with a higher socioeconomic status, would have greater tobacco outlet density despite having a similar White population percentage, and that jurisdictions with similar socioeconomic status and similar White population percentages would have similar tobacco outlet density.

Methods

Census Tract demographic data were obtained from the 2011-2015 American Community Survey (ACS), made available via the United States Census website. The American Community Survey, inaugurated in 2005, is a perennial survey administered by the U.S. Census Bureau that acquires data on the sociodemographic dynamics of people living in the United States (U.S. Census Bureau, 2016). The five-year pooled estimate of sociodemographic data was preferred over the one-year and three-year pooled estimates because of the larger dataset that included data for all areas, thus allowing for examination of small Residential Census Tracts, and greater reliability. Of the 1,406 Census Tracts in Maryland, 18 had a total population of less than 600 persons and consistent with the methodology from Fakunle et. al (2016) were excluded from analyses. The exclusion resulted in a final total of 1,388 included in the analyses. Maryland tobacco outlet data – including retailer names, contact information and retail/mailing locations – were obtained from the Maryland State Licensing Bureau, which provided the addresses for retailers with an active Cigarette, Special Cigarette, Other Tobacco Product (OTP) or Tobacconist licenses as of April 30, 2017. The sale of loose cigarettes in prohibited by Maryland state law, although licensed retailers may engage in the activity (Smith et. al, 2007). Tobacco outlet retail addresses were geocoded via MD iMap – the State of Maryland's Mapping and GIS Data Portal – the most current publicly available geocoding service for the state. Of the addresses

provided (n = 2,851), only five needed to be modified: one determined to be a duplicate (deleted), one determined to be out-of-state (Florida) with no alternative address given (deleted), one determined to have two adjacent addresses (second address added), one determined to be closed (deleted), and one geocoded with the mailing address due to the outlet being a food truck. Most of the licensed tobacco outlets were successfully geocoded after the first iteration. Of the revised total addresses (n = 2,849), all but 144 were successfully geocoded via the Batch Address Look-Up service. The 144 entries that did not return a geocode were cross-referenced with Google Maps and other internet-based resources (e.g., retailer websites) to verify the correct address. After verification, the addresses were re-run via the Single Address Look-Up service of which all but 19 were successfully geocoded. In total, 2,830 of the 2,849 addresses (99.3%) were successfully geocoded. The addresses were then merged with Maryland sociodemographic data via the Spatial Join tool in ArcGIS. It was then determined that a total of 3 tobacco outlets were located among the 18 Census Tracts excluded from analyses. Eight variables measuring racial composition, socioeconomic status and built environment were selected from the ACS dataset. The expansion of socioeconomic covariates beyond the study of two predominantly-Black locales in Maryland by Fakunle and colleagues (2016) was to provide a more thorough understanding of the relationship between socioeconomic status, race and tobacco outlet density beyond one measure – median household income (Mayers et. al, 2012; Rodriguez et. al, 2012; Lee et. al, 2017). Additionally, the expansion of socioeconomic covariates aimed to address the lack of consideration in research for income inequality's influence in health disparities (Kawachi & Kennedy, 1999; Subramanian & Kawachi, 2004; Fakunle et. al, 2010). The measures included in the study were the total population, the total number of individuals who identify as Black or African American (converted to a percentage), the total number of individuals who identify as

White (converted to a percentage), the percentage of individuals 25 years and over who have obtained at least a Bachelor's degree, the Gini index of income inequality (presented as a coefficient), the total number of vacant housing units, the total number of individuals 16 years and older who are actively in the labor force (converted to a percentage), and median household income, expressed in 2015 inflation-adjusted dollars. Residential Census Tracts have been the prevailing spatial unit of measurement in tobacco outlet density research, yet other spatial units have been utilized in tobacco outlet density studies such as census block groups, which are smaller and more refined than Residential Census Tracts (Reid et. al, 2005; Ogneva-Himmelberger et. al, 2010). Similar research in alcohol outlet density have also used census block groups as the spatial unit of measurement (Gorman et. al, 2001; Morrison et. al, 2016; Grubesic et. al, 2016). While there is no consensus unit of measurement, Residential Census Tracts are the most frequently used. Census block groups, while more refined than Residential Census Tracts, have more variation which can lead to analytical instability. Likewise, analyses of broad jurisdictions like cities, counties or states may lead to results that do not allow for inference (Yu et. al, 2010). Therefore, Residential Census Tracts are currently the best spatial units that both exude distinct neighborhood characteristics yet provide manageable data and potentially generalizable analysis results.

Statistical Analyses

Two-sample t-tests were conducted to compare the mean values per Census Tract of the study areas and provide a baseline measure of differences in tobacco outlet density and sociodemographic characteristics across areas. The two-sample t-tests were conducted via the SPSS statistical package. Spatial lag Poisson models were conducted to show the individual and collective effects of the sociodemographic covariates on tobacco outlet density both within and

across jurisdictions. Jurisdictions that were compared to each other in the two-sample t-tests were then compared to each other in place-based interaction Poisson models. These were conducted to determine if there were differences in the magnitude of relationship between covariates and tobacco outlet density based on location. The covariates were spatially lagged, meaning that the models included coefficients for the covariate in the immediate, proximal Census Tracts (focal effects) and the extended, distal environment around Census Tracts (spatial lag effects). To conduct spatial analyses of social factors and tobacco outlet density, neighborhood structures were created. In spatial statistics, a neighborhood structure is an arrangement of spatial data and in this study, an arrangement of tobacco outlet and sociodemographic data (Fischer & Gettis, 2013). For this analysis and to best adjust for spatial dependence, a "neighborhood" was defined as a Census Tract that shared at least more than one boundary with another Census Tract. Weight matrices – quantified representations of spatial relationships – were then created based on the neighborhood structures. The Census Tracts and sociodemographics data for each Tract provided the features needed to create the matrices. After the creation of the weight matrices, spatial smoothing was conducted to assure more consistent outcomes tobacco outlet density measures across the established Census Tracts. Spatial smoothing is a technique that aggregated the sociodemographic and tobacco outlet data across polygons (Census Tracts) to create more robust estimates and improve accuracy (Auchincloss et. al, 2012). The spatial smoothing was based on population, so areas with a higher population were weighted more heavily than area with a lower population. After spatial smoothing, Moran's I was tested to determine whether jurisdictions exhibited spatial dependence. Moran's I is a correlation coefficient, ranging from -1 to 1, that measures the extent of spatial dependence. A coefficient closer to 1 indicates similarity between adjacent areas, a coefficient closer to -1

indicates dissimilarity between adjacent areas, and a coefficient closer to zero indicates no correlation between adjacent areas (Statistics How To, 2017). All spatial analyses were conducted via the RStudio software package. Four models were conducted for each study area: a univariate model for each covariate, a multivariate model for focal effect covariates, a multivariate model for focal effect and spatially lagged covariates, and a multivariate model for focal effect and spatially lagged covariates, and interaction terms between the focal effect and spatially lagged covariates. Exponentiated beta coefficients were reported and magnified for easier interpretation. Due to the high number of significant coefficients in the models, the results section highlights focal effect and/or spatially lagged covariates that exhibited a consistent relationship (direct or inverse) across all four models. Chi-square statistics were conducted to determine the extent of overdispersion, or presence of greater variability, in the final model compared to the null model. Overdispersion occurs when the observed variance is greater than the theoretical variance, which is tied to the mean in Poisson models, and this indicates how much the models explain the variance of tobacco outlet density. The higher or lower the chi-square statistic, the more or less data are overdispersed.

Study Areas

Five jurisdictions were chosen for inclusion in this study based on preliminary examination of White population percentage and median household income. Baltimore County is in northeast Maryland, had 211 Census Tracts, was predominantly White (~66%), and had an average median household income totaling $73,114. Howard County is in central Maryland, has 55 Census Tracts, was predominantly White (~60%), and had an average median household income totaling $117,889. Lower Eastern Shore (Dorchester County, Somerset County, Wicomico County and Worcester County) is in southern Maryland, had 50 Census Tracts, was

predominantly White (~72%), and had an average median household income totaling $49,470. Montgomery County is in central Maryland, had 215 Census Tracts, was predominantly White (~58%), and had an average median household income totaling $109,126. Western Maryland (Allegany County, Garrett County and Washington County) is in western Maryland, had 62 Census Tracts, was predominantly White (~87%), and had an average median household income totaling $48,164. For reference, the White population percentage for the state of Maryland was 57.6% and the median household income totaled $74,551.

Results

Descriptives – Baltimore County and Howard County

There were statistically significant differences between Baltimore County and Howard County for some variables. Howard County was more affluent across all SES measures, especially median household income and percentage of individuals aged 25 years and older with at least a Bachelor's degree, and had lower tobacco outlet density than Baltimore County. This is despite Howard County having a significantly higher population density and there being no significant difference in White population percentage and number of vacant houses in both jurisdictions (see Table 3.1).

Descriptives – Western Maryland and Lower Eastern Shore

Western Maryland and Lower Eastern Shore are both predominantly-White jurisdictions yet, Western Maryland had a statistically significantly higher White population percentage. While there were no significant differences in population, median household income and labor force participation rate, Lower Eastern Shore had a significantly higher percentage of individuals aged 25 years and older with at least a Bachelor's degree. Western Maryland had a significantly

lower Gini income inequality coefficient, significantly fewer vacant houses, and significantly lower tobacco outlet density (see Table 3.2).

Descriptives – Howard County and Montgomery County

Howard County and Montgomery County had comparable incomes, labor force participation rates, number vacant houses, and percentages of individuals aged 25 years and older with at least a Bachelor's degree. While Howard County had a significantly higher population density and significant lower income inequality coefficient, both counties had statistically equal White population percentages and statistically equal tobacco outlet density (see Table 3.3).

Descriptives – Montgomery County and Baltimore County

There were statistically significant differences between Montgomery County and Baltimore County. Montgomery County was more affluent across all SES measures, especially median household income, percentage of individuals aged 25 years and older with at least a Bachelor's degree, and labor force participation rate. Despite Montgomery County having a significantly higher population density and Baltimore County having a significantly higher White population percentage, Montgomery County had a statistically significantly lower tobacco outlet density than Baltimore County (see Table 3.4).

Moran's I

Moran's I was tested to determine the extent of spatial dependence in the State of Maryland and the individual jurisdictions that were examined. The coefficient was conducted with both the number of tobacco outlets and the number of tobacco outlets per 1,000 persons per Census Tract as outcomes. For Lower Eastern Shore and Western Maryland, Moran's I was

tested on the counties that constitute both regions. The results showed that Montgomery County did not exhibit spatial dependence based on count (I = 0.001, p = 0.41) or tobacco outlet density (I = -0.01, p = 0.5). Baltimore County did not exhibit spatial dependence based on count (I = 0.05, p = 0.10) or tobacco outlet density (I = 0.02, p = 0.25). Allegany County (I = -0.14, p = 0.78 for count; I = -0.14, p = 0.80 for tobacco outlet density), Garrett County (I = -0.003, p = 0.16 for count; I = -0.18, p = 0.52 for tobacco outlet density), and Washington County (I = -0.15, p = 0.86 for count; I = -0.05, p = 0.54 for tobacco outlet density) – the three counties that comprise Western Maryland – did not exhibit spatial dependence. Howard County did not exhibit spatial dependence based on count (I = -0.06, p = 0.68) or tobacco outlet density (I = -0.05, p = 0.61). With the exception of Wicomico County based on tobacco outlet density (I = 0.22, p = 0.01), Lower Eastern Shore – Somerset County (I = 0.01, p = 0.18 for count), Wicomico County (I = 0.13, p = 0.06 for tobacco outlet density), Worcester County (I = 0.03, p = 0.19 based on count; I = -0.02, p = 0.33 based on tobacco outlet density), and Dorchester County (I = -0.08, p = 0.36 based on count; I = -0.04, p = 0.25 based on tobacco outlet density) – did not exhibit spatial dependence. However, because Maryland exhibited spatial dependence based on count (I = 0.40, p = 0.001) and tobacco outlet density (I = 0.51, p = 0.001), spatial lag modeling was conducted due to the state's inclusion of 24 jurisdictions, including the f study areas.

Univariate and Multivariate Spatial Lag Models – Baltimore County

In Baltimore County, there was an inverse relationship between the percentage of individuals aged 25 years and older with at least a Bachelor's degree and tobacco outlet density in proximal Census Tracts, an inverse relationship between vacant houses and tobacco outlet density in proximal Census Tracts, an inverse relationship between White population percentage

and tobacco outlet density in distal Census Tracts, an inverse relationship between median household income and tobacco outlet density in distal Census Tract neighborhoods, and an inverse relationship between income inequality and tobacco outlet density in distal Census Tract neighborhoods. Conversely, there was a direct relationship between White population percentage and tobacco outlet density in proximal Census Tracts and a direct relationship between vacant houses and tobacco outlet density in distal Census Tract neighborhoods (see Table 3.5). In the final model, the strongest relationship with tobacco outlet density was a direct relationship between labor force participation rate and tobacco outlet density in proximal Census Tracts, followed by a direct relationship between labor force participation rate and tobacco outlet density in distal Census Tract neighborhoods (see Table 3.6). Chi-square statistics showed a reduction in overdispersion between the null model ($\chi 2 = 432{,}403.6$) and final model ($\chi 2 = 292{,}022.1$).

Univariate and Multivariate Spatial Lag Models – Howard County

In Howard County, there was an inverse relationship between median household income and tobacco outlet density in proximal Census Tracts, and an inverse relationship between vacant houses and tobacco outlet density in distal Census Tract neighborhoods. Conversely there was a direct relationship between vacant houses and tobacco outlet density in proximal Census Tracts, a direct relationship between White population percentage and tobacco outlet density in distal Census Tract neighborhoods, and a direct relationship between income inequality and tobacco outlet density in distal Census Tract neighborhoods (see Table 3.7). In the final model, the strongest relationship with tobacco outlet density was a direct relationship between labor force participation rate and tobacco outlet density in distal Census Tract environments, followed by a direct relationship between labor force participation rate and tobacco outlet density in proximal Census Tracts (see Table 3.8). Chi-square statistics showed a reduction in overdispersion

between the null model ($\chi 2 = 75{,}487.89$) and the final model ($\chi 2 = 44{,}175.13$).

Univariate and Multivariate Spatial Lag Models – Lower Eastern Shore

In Lower Eastern Shore, there was a direct relationship between White population percentage and tobacco outlet density in proximal Census Tracts (see Table 3.9). In the final model, the strongest relationship with tobacco outlet density was a direct relationship between labor force participation rate and tobacco outlet density in proximal Census Tracts, followed by a direct relationship between labor force participation rate and tobacco outlet density in distal Census Tract neighborhoods (see Table 3.10). Chi-square statistics showed a reduction in overdispersion between the null model ($\chi 2 = 485{,}050.4$) and final model ($\chi 2 = 96{,}052.51$).

Univariate and Multivariate Spatial Lag Models – Montgomery County

In Montgomery County, there was an inverse relationship between median household income and tobacco outlet density in both proximal Census Tracts and distal Census Tract environments. Conversely, there was a direct relationship between the percentage of individuals aged 25 years and older with at least a Bachelor's degree and tobacco outlet density in proximal Census Tracts, a direct relationship between vacant houses and tobacco outlet density in both proximal Census Tracts and distal Census Tract neighborhoods, and a direct relationship between labor force participation rate and tobacco outlet density in distal Census Tract neighborhoods (see Table 3.11). In the final model, the strongest relationship with tobacco outlet density was a direct relationship between labor force participation rate and tobacco outlet density in distal Census Tract environments, followed by a direct relationship between labor force participation rate and tobacco outlet density in proximal Census Tracts (see Table 3.12). Chi-square statistics showed a reduction in overdispersion between the null model ($\chi 2 = 772{,}823.3$) and the final model ($\chi 2 = 454{,}107.7$).

Univariate and Multivariate Spatial Lag Models – Western Maryland

In Western Maryland, there was a direct relationship between White population percentage and tobacco outlet density in proximal Census Tracts, as well as a direct relationship between income inequality and tobacco outlet density in both proximal and distal Census Tracts. Conversely there was an inverse relationship between median household income and tobacco outlet density in proximal Census Tracts, and an inverse relationship between the percentage of individuals aged 25 years and older with at least a Bachelor's degree and tobacco outlet density in distal Census Tracts (see Table 3.13). In the final model, the strongest relationship with tobacco outlet density was a direct relationship between labor force participation rate and tobacco outlet density in distal Census Tract environments, followed by a direct relationship between labor force participation rate and tobacco outlet density in proximal Census Tracts (see Table 3.14). Chi-square statistics showed a reduction in overdispersion between the null model (χ^2 = 77,253.34) and the final model (χ^2 = 51,212.85).

Place-Based Interaction Models

Jurisdictions that were compared to each other in the two-sample t-tests were then compared to each other in place-based interaction Poisson models. Place-based interaction Poisson models were conducted to determine if there were differences in the magnitude of the relationship between sociodemographic covariates and tobacco outlet density based on location. Consistent with the hypothesis of SES relating to tobacco outlet despite similar racial concentration, it was proposed that the strength of relationship between covariates and tobacco outlet density would be greater in the jurisdiction with lower SES (signified by an exponentiated beta different than 1). While the direction of the relationship was noteworthy, the salience was in showing that the degree to which covariates related to tobacco outlet density varied between two

jurisdictions. To assure consistency the jurisdiction with the lower tobacco outlet density was set as the reference variable, and due to the high number of significant coefficients in the model, this section highlighted covariates that exhibited a consistent relationship (direct or inverse) among both focal effects and spatial lag effects.

Baltimore County – Montgomery County

There were significant differences in the magnitude of relationships between covariates and tobacco outlet density in Baltimore County when compared to Montgomery County. Baltimore County had significantly lower measures of SES than Montgomery County, as well as significantly higher tobacco outlet density. In the model, there was an inverse relationship between median household income and tobacco outlet density, as well as an inverse relationship between income inequality and tobacco outlet density. Conversely, there was a direct relationship between labor force participation rate and tobacco outlet density and a direct relationship between vacant houses and tobacco outlet density. The strongest relationship with tobacco outlet density was a direct relationship labor force participation rate and tobacco outlet density in distal Census Tract neighborhoods, followed by a direct relationship between labor force participation rate and tobacco outlet density in proximal Census Tracts (see Table 3.15).

Montgomery County – Howard County

There were significant differences in the magnitude of relationships between covariates and tobacco outlet density in Montgomery County when compared to Howard County. Except for income inequality and population, there were no differences in SES measures or tobacco outlet density between Montgomery County and Howard County. In the model, there was an inverse relationship between median household income and tobacco outlet density and an inverse relationship between income inequality and tobacco outlet density. Conversely, there was a

direct relationship between labor force participation rate and tobacco outlet density, a direct relationship between the percentage of individuals aged 25 years and older with at least a Bachelor's degree and tobacco outlet density, and a direct relationship between vacant houses and tobacco outlet density. The strongest relationship with tobacco outlet density was a direct relationship between labor force participation rate and tobacco outlet density in distal Census Tract neighborhoods density, followed by a direct relationship between labor force participation rate and tobacco outlet density in proximal Census Tracts (see Table 3.16).

Western Maryland – Lower Eastern Shore

The place-based interaction model of Western Maryland and Lower Eastern shore did not involve a reference due to both jurisdictions being regions rather than counties. To account for the lack of reference, the model controlled for the counties that comprise both regions. In the model, there was an inverse relationship between White population percentage and tobacco outlet density, an inverse relationship between median household income and tobacco outlet density, an inverse relationship between the percentage of individuals aged 25 years and older with at least a Bachelor's degree and tobacco outlet density, an inverse relationship between income inequality and tobacco outlet density, and an inverse relationship between vacant houses and tobacco outlet density. Conversely, there was a direct relationship between labor force participation rate and tobacco outlet density. The strongest relationship with tobacco outlet density was a direct relationship between labor force participation rate and tobacco outlet density in distal Census Tract neighborhoods, followed by a direct relationship between labor force participation rate and tobacco outlet density in proximal Census Tracts (see Table 3.17).

Baltimore County – Howard County

There were significant differences in the magnitude of relationships between covariates

and tobacco outlet density Baltimore County compared to Howard County. Like the comparison with Montgomery County, Baltimore County had significantly lower measures of SES, as well as significantly higher tobacco outlet density, than Howard County. In the model, there was an inverse relationship between White population percentage and tobacco outlet density, an inverse relationship between median household income and tobacco outlet density, and an inverse relationship between income inequality and tobacco outlet density. Conversely, there was a direct relationship between the percentage of individuals aged 25 years and older with at least a Bachelor's degree and tobacco outlet density, and a direct relationship between labor force participation rate and tobacco outlet density. The strongest relationship with tobacco outlet density was a direct relationship between labor force participation rate and tobacco outlet density in proximal Census Tract neighborhoods, followed by a direct relationship between labor force participation rate and tobacco outlet density in distal Census Tracts neighborhoods (see Table 3.18).

Discussion

The objective of this study was to examine the relationship between socioeconomic status and tobacco outlet density in predominantly-White Maryland jurisdictions, with the aim of testing the hypothesis that there would be an inverse relationship between socioeconomic status and tobacco outlet density despite a similar White population percentage. The first key finding was that the descriptives of sociodemographics and tobacco outlet density showed areas with higher measures of socioeconomic status, despite similar racial concentration, had lower tobacco outlet density. These patterns are consistent with the hypothesis and with findings from Fakunle et. al (2016), and contribute to the proposition that the relationship between sociodemographics and tobacco outlet density follows a socioeconomic gradient regardless of racial composition.

However, the descriptives showed that when compared to each other, areas with similar measures of socioeconomic status and similar racial concentrations did not have similar tobacco outlet density, which is not consistent with the hypothesis and past research. The suggestion is that the difference in tobacco outlet density was reflective of the difference in urbanicity between Lower Eastern Shore and Western Maryland. While both locales are considered rural, Western Maryland exhibits more rurality (i.e., less urbanicity) than Lower Eastern Shore (Towson Patch, 2016). The second key finding resulted from the spatial regression models, which allowed for detailed analyses of sociodemographics and tobacco outlet density within and across the study areas. In 12 of the 14 total spatial analyses models, median household income within proximal Census Tracts and/or distal Census Tract neighborhoods exhibited an inverse relationship with tobacco outlet density. This finding is consistent with past tobacco outlet density studies (Hyland et. al, 2003; Peterson et. al, 2005; Fakunle et. al, 2010; Fakunle et. al, 2016; Rodriguez et. al, 2013). The implication is that median household income may be the best predictor of tobacco outlet density among measures of socioeconomic status, and coupled with the first key finding, suggests that municipalities should at least consider the household income of neighborhoods, regardless of the racial composition, when determining the number of tobacco outlets to allow. Among all five study areas labor force participation rate had the largest exponentiated beta coefficient in the final spatial model, which included interaction terms for all the examined sociodemographic covariates. It is difficult to provide a rationale, but a suggestion is that the magnitude of the relationship with tobacco outlet density was reflective of the statistical interaction between sociodemographics in proximal Census Tracts and sociodemographics in distal Census Tract neighborhoods. In each study area, the exponentiated beta coefficient for labor force participation rate was higher in the multivariate model with interaction terms than the

multivariate model without interaction terms. Conceptually, the magnitude of the relationship with tobacco outlet density may be reflective the high labor force participations rates in most of the jurisdictions. All five jurisdictions had a labor force participation rate of at least 60%. Finally, it is suggested that the direct relationship between labor force participation rate and tobacco outlet density was reflective of the higher populations in most of the study areas. All five jurisdictions had total population totaling at least 200,000. Nevertheless, the consistency of labor force participation rate's magnitude implies that tobacco control policies should be considerate of neighborhoods' employment levels, particularly in concurrence with median household income.

It is important to maintain an appropriate context when considering the findings of this study, because while statistical methodology allows researchers to parse through multifaceted relationships, the interaction of race and socioeconomic status is an inherently complex relationship. The most salient covariates, and their relationships with tobacco outlet density, were determined based on consistency shown across several spatial regression models as well as the two-sample t-tests. However, nearly all the covariates included in the models showed a significant association in one direction or the other. That exemplifies both the complexities of socioeconomic status and the contextual interaction of race, socioeconomic status and tobacco outlet density. However, the results demonstrate that perhaps median household income encompasses enough of socioeconomic status as a construct to be a deciding metric by which tobacco use reduction interventions are administered. What makes this demonstration more salient is that it was shown among predominantly White jurisdictions. Whites are a racial group under-researched in tobacco outlet density. Fakunle and colleagues previously showed this association among predominantly Black areas in Maryland, and much of the explanation around

the influence of socioeconomic status and tobacco outlet density focused on the effects of institutional racism and its many manifestations, including redlining and segregation (Fakunle et. al, 2016). The presence of a similar association in White jurisdictions does not invalidate the mechanisms that may explain inequitable tobacco outlet distributions in predominantly Black jurisdictions, but it does suggest that similarly-premised mechanisms that detrimentally affect lower-income neighborhoods may explain inequitable distributions in predominantly White areas.

One strength of this study is that it investigated the influence of White populations on tobacco outlet density. Historically tobacco outlet density research has restricted its focus on the association with race and tobacco outlet density to non-White racial groups such as Blacks and Latin/x, while Whites have been utilized as the reference or not studied at all. This is perhaps reflective of past research which showed direct relationships between non-White populations and tobacco advertising (Laws et. al, 2002; Hyland et. al, 2003; Luke et. al, 2000; Barbeau et. al, 2005; Fakunle et. al, 2010). However, this study acknowledged that Whites are the majority racial group in most jurisdictions in Maryland and therefore garnered an in-depth exploration. Additionally, this study expanded beyond jurisdictions with similar racial concentrations yet disparate median household incomes to include jurisdictions with similar racial concentrations and similar socioeconomic metrics. This allowed for a more detailed examination of socioeconomic status as a construct, showing that not all metrics behave in the same manner, and exhibited the consistent relationship between socioeconomic status and tobacco outlet density at different magnitudes.

This study concludes that jurisdictions with relatively higher socioeconomic status, despite similar concentrations of Whites to jurisdictions with relatively lower socioeconomic

status, exhibit lower tobacco outlet density. Additionally, this study concludes that median household income exhibits the most consistent association with tobacco outlet density among several metrics of socioeconomic status.

Table 3.1: Descriptives of Sociodemographics and Tobacco Outlet Density of Baltimore County and Howard County, Maryland

Mean Characteristic Per Census Tract	Baltimore County (# Tracts = 211)	Howard County (# Tracts = 55)	*t-statistic*[1]	*df*
Population (SD)	3,900.28 (1,638.74)	5,529.36 (1,596.77)	***-6.60***	*264*
Black Population Percentage (SD)	24.92 (26.55)	17.94 (12.59)	*1.89*	*264*
White Population Percentage (SD)	66.21 (26.96)	60.17 (14.31)	*1.60*	*264*
Median Household Income (SD)	$73,114 ($26,299)	$117,889 ($35,909)	***-10.37***	*264*
Gini Coefficient (SD)	0.40 (0.05)	0.36 (0.05)	***5.28***	*264*
Percentage of Individuals Aged 25+ with at Least a Bachelor's Degree (SD)	35.52 (19.86)	61.10 (11.53)	***-9.15***	*264*
Labor Force Participation Rate (SD)[2]	66.34 (8.97)	72.76 (6.13)	***-5.01***	*264*
Number of Vacant Houses	112.71 (95.46)	89.73 (77.42)	*1.65*	*264*
Tobacco Outlets per 1000 (SD)	0.35 (0.49)	0.17 (0.22)	***2.65***	*264*

[1] boldface indicates statistical significance of $p<0.05$.
[2] for individuals aged 16 years and older.

Table 3.2: Descriptives of Sociodemographics and Tobacco Outlet Density of Western Maryland and Lower Eastern Shore, Maryland

Mean Characteristic Per Census Tract	Western Maryland (# Tracts = 62)	Lower Eastern Shore (# Tracts = 50)	*t-statistic*	*df*
Population (SD)	4,074.71 (1,808.71)	4,244.30 (1,882.36)	*-0.48*	*110*
Black Population Percentage (SD)	7.96 (11.78)	23.12 (21.36)	***-4.76***	*110*
White Population Percentage (SD)	87.38 (13.78)	71.70 (22.59)	***4.52***	*110*
Median Household Income (SD)	$48,164 ($18,290)	$49,470 ($20,400)	*-0.36*	*110*
Gini Coefficient (SD)	0.41 (0.07)	0.44 (0.05)	***-2.55***	*110*
Percentage of Individuals Aged 25+ with at Least a Bachelor's Degree (SD)	18.40 (9.22)	25.13 (11.18)	***-3.49***	*110*
Labor Force Participation Rate (SD)	59.57 (11.47)	60.38 (11.29)	*-0.37*	*110*
Number of Vacant Houses	276.47 (555.03)	917.82 (2,170.31)	***-2.24***	*110*
Tobacco Outlets per 1000 (SD)	0.22 (0.29)	0.64 (1.46)	***-2.21***	*110*

Table 3.3: Descriptives of Sociodemographics and Tobacco Outlet Density of Howard County and Montgomery County, Maryland

Mean Characteristic Per Census Tract	Howard County (# Tracts = 55)	Montgomery County (# Tracts = 215)	*t-statistic*	*df*
Population (SD)	5,529.36 (1,596.77)	4,734.23 (1,703.52)	***3.13***	*268*
Black Population Percentage (SD)	17.94 (12.59)	16.51 (13.86)	*0.70*	*268*
White Population Percentage (SD)	60.17 (14.31)	57.93 (20.65)	*0.76*	*268*
Median Household Income (SD)	$117,889 ($35,909)	$109,126 ($44,592)	*1.35*	*268*
Gini Coefficient (SD)	0.36 (0.05)	0.39 (0.05)	***-3.97***	*268*
Percentage of Individuals Aged 25+ with at Least a Bachelor's Degree (SD)	61.10 (11.53)	58.64 (18.52)	*0.94*	*268*
Labor Force Participation Rate (SD)	72.76 (6.13)	71.69 (9.16)	*0.82*	*268*
Number of Vacant Houses	89.73 (77.42)	82.22 (63.53)	*0.75*	*268*
Tobacco Outlets per 1000 (SD)	0.17 (0.22)	0.20 (0.42)	*-0.51*	*268*

Table 3.4: Descriptives of Sociodemographics and Tobacco Outlet Density of Baltimore County and Montgomery County, Maryland

Mean Characteristic Per Census Tract	Baltimore County (# Tracts = 211)	Montgomery County (# Tracts = 215)	*t-statistic*	*df*
Population (SD)	3,900.28 (1,638.74)	4,734.23 (1,703.52)	***-5.15***	*424*
Black Population Percentage (SD)	24.92 (26.55)	16.51 (13.86)	***4.11***	*424*
White Population Percentage (SD)	66.21 (26.96)	57.93 (20.65)	***3.56***	*424*
Median Household Income (SD)	$73,114 ($26,299)	$109,126 ($44,592)	***-10.13***	*424*
Gini Coefficient (SD)	0.40 (0.05)	0.39 (0.05)	***2.06***	*424*
Percentage of Individuals Aged 25+ with at Least a Bachelor's Degree (SD)	35.52 (19.86)	58.64 (18.52)	***-12.43***	*424*
Labor Force Participation Rate (SD)	66.34 (8.97)	71.69 (9.16)	***-6.09***	*424*
Number of Vacant Houses (SD)	112.71 (95.46)	82.22 (63.53)	***3.89***	*424*
Tobacco Outlets per 1000 (SD)	0.35 (0.49)	0.20 (0.42)	***3.39***	*424*

Table 3.5: Spatial Lag Regression Model Coefficients for Sociodemographic Covariates in Baltimore County, Maryland – 2011-2015

Variable	Univariate Model		Multivariate Model			
			Focal Effects		Focal & Spatial Lag	
	Exponentiated Beta	p-value	Exponentiated Beta	p-value	Exponentiated Beta	p-value
Focal Effects						
White Population Percentage (per 10%)	**1.02**	**<0.001**	**1.16**	**<0.001**	**1.13**	**<0.001**
Median Household Income (per $10000)	**0.93**	**<0.001**	**0.98**	**0.01**	**0.99**	**<0.001**
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**0.85**	**<0.001**	**0.81**	**<0.001**	**0.87**	**<0.001**
Labor Force Participation Rate (per 10%)	**0.93**	**<0.001**	**1.11**	**<0.001**	**1.11**	**<0.001**
Gini Income Inequality Coefficient (per 1%)	**1.02**	**<0.001**	**1.05**	**<0.001**	**1.05**	**<0.001**
Vacant Houses (per 100)	**0.82**	**<0.001**	**0.78**	**<0.001**	**0.79**	**<0.001**
Spatial Lag						
White Population Percentage (per 10%)	**0.96**	**<0.001**			**0.86**	**<0.001**
Median Household Income (per $10000)	**0.79**	**<0.001**			**0.81**	**<0.001**
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**0.82**	**<0.001**			**1.15**	**<0.001**
Labor Force Participation Rate (per 10%)	**0.68**	**<0.001**			**0.63**	**<0.001**
Gini Income Inequality Coefficient (per 1%)	**0.97**	**<0.001**			**0.95**	**<0.001**
Vacant Houses (per 100)	**1.48**	**<0.001**			**1.11**	**<0.001**

Table 3.6: Spatial Lag Covariate Interaction Regression Model Coefficients in Baltimore County, Maryland – 2011-2015

Variable	Multivariate Model			
	Focal & Spatial Lag		**Focal & Spatial Lag Interaction**	
	Exponentiated Beta	p-value	Exponentiated Beta	p-value
Focal Effects				
White Population Percentage (per 10%)	**1.05**	**<0.001**	**1.00**	**<0.001**
Median Household Income (per $10000)	**1.12**	**<0.001**	**1.00**	**<0.001**
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**0.98**	**<0.001**	**1.00**	**<0.001**
Labor Force Participation Rate (per 10%)	**37.64**	**<0.001**	**0.95**	**<0.001**
Gini Income Inequality Coefficient (per 1%)	**0.85**	**<0.001**	**1.68**	**<0.001**
Vacant Houses (per 100)	**0.86**	**<0.001**	**1.00**	**<0.001**
Spatial Lag				
White Population Percentage (per 10%)	**0.83**	**<0.001**		
Median Household Income (per $10000)	**0.91**	**<0.001**		
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**1.13**	**<0.001**		
Labor Force Participation Rate (per 10%)	**30.57**	**<0.001**		
Gini Income Inequality Coefficient (per 1%)	**0.78**	**<0.001**		
Vacant Houses (per 100)	**1.29**	**<0.001**		

Table 3.7: Spatial Lag Regression Model Coefficients for Sociodemographic Covariates in Howard County, Maryland – 2011-2015

Variable	Univariate Model		Multivariate Model			
			Focal Effects		Focal & Spatial Lag	
	Exponentiated Beta	p-value	Exponentiated Beta	p-value	Exponentiated Beta	p-value
Focal Effects						
White Population Percentage (per 10%)	**0.87**	**<0.001**	**0.94**	**<0.001**	**0.74**	**<0.001**
Median Household Income (per $10000)	**0.95**	**<0.001**	**0.93**	**0.01**	**0.89**	**<0.001**
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**0.96**	**<0.001**	**1.09**	**<0.001**	**1.10**	**<0.001**
Labor Force Participation Rate (per 10%)	**0.69**	**<0.001**	**0.66**	**<0.001**	**0.81**	**<0.001**
Gini Income Inequality Coefficient (per 1%)	**1.01**	**<0.001**	**0.94**	**<0.001**	**0.97**	**<0.001**
Vacant Houses (per 100)	**1.59**	**<0.001**	**1.68**	**<0.001**	**1.61**	**<0.001**
Spatial Lag						
White Population Percentage (per 10%)	**1.02**	**<0.001**			**1.37**	**<0.001**
Median Household Income (per $10000)	**1.09**	**<0.001**			**1.26**	**<0.001**
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**0.83**	**<0.001**			**0.74**	**<0.001**
Labor Force Participation Rate (per 10%)	**0.95**	**<0.001**			**1.30**	**<0.001**
Gini Income Inequality Coefficient (per 1%)	**2.40**	**<0.001**			**1.08**	**<0.001**
Vacant Houses (per 100)	**0.93**	**<0.001**			**0.69**	**<0.001**

Table 3.8: Spatial Lag Covariate Interaction Regression Model Coefficients in Howard County, Maryland – 2011-2015

Variable	Multivariate Model			
	Focal & Spatial Lag		**Focal & Spatial Lag Interaction**	
	Exponentiated Beta	p-value	Exponentiated Beta	p-value
Focal Effects				
White Population Percentage (per 10%)	**1.12**	**<0.001**	**0.99**	**<0.001**
Median Household Income (per $10000)	**0.37**	**<0.001**	**1.00**	**<0.001**
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**10.38**	**<0.001**	**0.97**	**<0.001**
Labor Force Participation Rate (per 10%)	**77.63**	**<0.001**	**0.94**	**<0.001**
Gini Income Inequality Coefficient (per 1%)	**2.38**	**<0.001**	**0.09**	**<0.001**
Vacant Houses (per 100)	**1.84**	**<0.001**	**1.00**	**<0.001**
Spatial Lag				
White Population Percentage (per 10%)	**2.02**	**<0.001**		
Median Household Income (per $10000)	**0.54**	**<0.001**		
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**6.83**	**<0.001**		
Labor Force Participation Rate (per 10%)	**160.93**	**<0.001**		
Gini Income Inequality Coefficient (per 1%)	**2.53**	**<0.001**		
Vacant Houses (per 100)	**0.81**	**<0.001**		

Table 3.9: Spatial Lag Regression Model Coefficients for Sociodemographic Covariates in Lower Eastern Shore, Maryland – 2011-2015

Variable	Univariate Model		Multivariate Model			
			Focal Effects		Focal & Spatial Lag	
	Exponentiated Beta	p-value	Exponentiated Beta	p-value	Exponentiated Beta	p-value
Focal Effects						
White Population Percentage (per 10%)	**1.24**	**<0.001**	**1.02**	**<0.001**	**1.03**	**<0.001**
Median Household Income (per $10000)	**1.00**	**<0.001**	**1.05**	**<0.001**	**1.14**	**<0.001**
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**1.32**	**<0.001**	**0.95**	**<0.001**	**0.82**	**<0.001**
Labor Force Participation Rate (per 10%)	1.00	0.61	**1.31**	**<0.001**	**1.46**	**<0.001**
Gini Income Inequality Coefficient (per 1%)	**1.20**	**<0.001**	**1.20**	**<0.001**	**1.23**	**<0.001**
Vacant Houses (per 100)	**1.02**	**<0.001**	**1.02**	**<0.001**	**1.02**	**<0.001**
Spatial Lag						
White Population Percentage (per 10%)	**1.44**	**<0.001**			**0.91**	**<0.001**
Median Household Income (per $10000)	**1.07**	**<0.001**			**1.22**	**<0.001**
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**1.81**	**<0.001**			**1.05**	**<0.001**
Labor Force Participation Rate (per 10%)	**0.91**	**<0.001**			**0.93**	**<0.001**
Gini Income Inequality Coefficient (per 1%)	**1.12**	**<0.001**			**1.11**	**<0.001**
Vacant Houses (per 100)	**1.04**	**<0.001**			**1.00**	**<0.001**

Table 3.10: Spatial Lag Covariate Interaction Regression Model Coefficients in Lower Eastern Shore, Maryland – 2011-2015

Variable	Multivariate Model			
	Focal & Spatial Lag		**Focal & Spatial Lag Interaction**	
	Exponentiated Beta	p-value	Exponentiated Beta	p-value
Focal Effects				
White Population Percentage (per 10%)	**1.15**	**<0.001**	**1.00**	**<0.001**
Median Household Income (per $10000)	**0.28**	**<0.001**	**1.00**	**<0.001**
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**0.79**	**<0.001**	**1.00**	**0.03**
Labor Force Participation Rate (per 10%)	**2.97**	**<0.001**	**0.99**	**<0.001**
Gini Income Inequality Coefficient (per 1%)	**0.28**	**<0.001**	**29.05**	**<0.001**
Vacant Houses (per 100)	**1.00**	**<0.01**	**1.00**	**<0.001**
Spatial Lag				
White Population Percentage (per 10%)	1.02	0.59		
Median Household Income (per $10000)	**0.34**	**<0.001**		
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	1.01	0.85		
Labor Force Participation Rate (per 10%)	**1.91**	**<0.001**		
Gini Income Inequality Coefficient (per 1%)	**0.27**	**<0.001**		
Vacant Houses (per 100)	**0.96**	**<0.001**		

Table 3.11: Spatial Lag Regression Model Coefficients for Sociodemographic Covariates in Montgomery County, Maryland – 2011-2015

Variable	Univariate Model		Multivariate Model			
			Focal Effects		Focal & Spatial Lag	
	Exponentiated Beta	p-value	Exponentiated Beta	p-value	Exponentiated Beta	p-value
Focal Effects						
White Population Percentage (per 10%)	**1.00**	**0.003**	**1.07**	**<0.001**	**0.97**	**<0.001**
Median Household Income (per $10000)	**0.94**	**<0.001**	**0.91**	**<0.001**	**0.97**	**<0.001**
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**1.05**	**<0.001**	**1.09**	**<0.001**	**1.39**	**<0.001**
Labor Force Participation Rate (per 10%)	**1.04**	**<0.001**	**1.15**	**<0.001**	**0.97**	**<0.001**
Gini Income Inequality Coefficient (per 1%)	**1.05**	**<0.001**	**1.05**	**<0.001**	**1.05**	**<0.001**
Vacant Houses (per 100)	**1.75**	**<0.001**	**1.63**	**<0.001**	**1.59**	**<0.001**
Spatial Lag						
White Population Percentage (per 10%)	**0.97**	**<0.001**			**1.47**	**<0.001**
Median Household Income (per $10000)	**0.92**	**<0.001**			**0.91**	**<0.001**
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**0.96**	**<0.001**			**0.58**	**<0.001**
Labor Force Participation Rate (per 10%)	**2.19**	**<0.001**			**2.05**	**<0.001**
Gini Income Inequality Coefficient (per 1%)	**1.04**	**<0.001**			**1.06**	**<0.001**
Vacant Houses (per 100)	**2.30**	**<0.001**			**1.46**	**<0.001**

Table 3.12: Spatial Lag Covariate Interaction Regression Model Coefficients in Montgomery County, Maryland – 2011-2015

Variable	Multivariate Model			
	Focal & Spatial Lag		**Focal & Spatial Lag Interaction**	
	Exponentiated Beta	p-value	Exponentiated Beta	p-value
Focal Effects				
White Population Percentage (per 10%)	**0.93**	**<0.001**	**1.00**	**<0.001**
Median Household Income (per $10000)	**0.99**	**<0.001**	**1.00**	**<0.001**
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**2.94**	**<0.001**	**0.99**	**<0.001**
Labor Force Participation Rate (per 10%)	**9.17**	**<0.001**	**0.97**	**<0.001**
Gini Income Inequality Coefficient (per 1%)	**0.67**	**<0.001**	**3.19**	**<0.001**
Vacant Houses (per 100)	**1.42**	**<0.001**	**1.00**	**<0.001**
Spatial Lag				
White Population Percentage (per 10%)	**1.35**	**<0.001**		
Median Household Income (per $10000)	**0.92**	**<0.001**		
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**1.35**	**<0.001**		
Labor Force Participation Rate (per 10%)	**13.64**	**<0.001**		
Gini Income Inequality Coefficient (per 1%)	**0.71**	**<0.001**		
Vacant Houses (per 100)	**1.34**	**<0.001**		

Table 3.13: Spatial Lag Regression Model Coefficients for Sociodemographic Covariates in Western Maryland – 2011-2015

Variable	Univariate Model		Multivariate Model			
			Focal Effects		Focal & Spatial Lag	
	Exponentiated Beta	p-value	Exponentiated Beta	p-value	Exponentiated Beta	p-value
Focal Effects						
White Population Percentage (per 10%)	**1.13**	**<0.001**	**1.27**	**<0.001**	**1.53**	**<0.001**
Median Household Income (per $10000)	**0.85**	**<0.001**	**0.88**	**<0.001**	**0.92**	**<0.001**
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**0.94**	**<0.001**	**0.94**	**<0.001**	**1.03**	**<0.01**
Labor Force Participation Rate (per 10%)	1.00	0.92	**0.87**	**<0.001**	**0.72**	**<0.001**
Gini Income Inequality Coefficient (per 1%)	**1.03**	**<0.001**	**1.04**	**<0.001**	**1.04**	**<0.001**
Vacant Houses (per 100)	**0.99**	**<0.001**	**0.96**	**<0.001**	**0.96**	**<0.001**
Spatial Lag						
White Population Percentage (per 10%)	**0.93**	**<0.001**			**0.74**	**<0.001**
Median Household Income (per $10000)	**0.90**	**<0.001**			**1.13**	**<0.001**
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**0.69**	**<0.001**			**0.72**	**<0.001**
Labor Force Participation Rate (per 10%)	**0.73**	**<0.001**			**1.27**	**<0.001**
Gini Income Inequality Coefficient (per 1%)	**1.05**	**<0.001**			**1.07**	**<0.001**
Vacant Houses (per 100)	**0.99**	**<0.001**			**0.99**	**<0.001**

Table 3.14: Spatial Lag Covariate Interaction Regression Model Coefficients in Western Maryland – 2011-2015

Variable	Multivariate Model			
	Focal & Spatial Lag		**Focal & Spatial Lag Interaction**	
	Exponentiated Beta	p-value	Exponentiated Beta	p-value
Focal Effects				
White Population Percentage (per 10%)	**1.64**	**<0.001**	**1.00**	**0.05**
Median Household Income (per $10000)	**0.80**	**<0.001**	**1.00**	**<0.001**
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**0.09**	**<0.001**	**1.13**	**<0.001**
Labor Force Participation Rate (per 10%)	**270.16**	**<0.001**	**0.91**	**<0.001**
Gini Income Inequality Coefficient (per 1%)	**1.79**	**<0.001**	**0.29**	**<0.001**
Vacant Houses (per 100)	1.00	0.51	**1.00**	**<0.001**
Spatial Lag				
White Population Percentage (per 10%)	1.02	0.78		
Median Household Income (per $10000)	1.03	0.08		
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**0.08**	**<0.001**		
Labor Force Participation Rate (per 10%)	**327.01**	**<0.001**		
Gini Income Inequality Coefficient (per 1%)	**1.79**	**<0.001**		
Vacant Houses (per 100)	**1.03**	**<0.001**		

Table 3.15: Spatial Lag Covariate Interaction Regression Model Coefficients in Baltimore County, Maryland Compared to Montgomery County, Maryland – 2011-2015

Variable	Multivariate Model			
	Focal & Spatial Lag		Focal & Spatial Lag Interaction	
	Exponentiated Beta	p-value	Exponentiated Beta	p-value
Focal Effects				
White Population Percentage (per 10%)	**1.01**	**<0.001**	**1.00**	**<0.001**
Median Household Income (per $10000)	**0.95**	**<0.001**	**1.00**	**0.01**
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**1.03**	**<0.001**	**1.00**	**<0.001**
Labor Force Participation Rate (per 10%)	**6.34**	**<0.001**	**0.97**	**<0.001**
Gini Income Inequality Coefficient (per 1%)	**0.86**	**<0.001**	**1.63**	**<0.001**
Vacant Houses (per 100)	**1.06**	**<0.001**	**1.00**	**<0.001**
Spatial Lag				
White Population Percentage (per 10%)	**0.95**	**<0.001**		
Median Household Income (per $10000)	**0.83**	**<0.001**		
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**0.85**	**<0.001**		
Labor Force Participation Rate (per 10%)	**7.16**	**<0.001**		
Gini Income Inequality Coefficient (per 1%)	**0.82**	**<0.001**		
Vacant Houses (per 100)	**1.62**	**<0.001**		
County	**0.64**	**<0.001**		

Table 3.16: Spatial Lag Covariate Interaction Regression Model Coefficients in Montgomery County, Maryland Compared to Howard County, Maryland – 2011-2015

Variable	Multivariate Model			
	Focal & Spatial Lag		Focal & Spatial Lag Interaction	
	Exponentiated Beta	p-value	Exponentiated Beta	p-value
Focal Effects				
White Population Percentage (per 10%)	**0.87**	**<0.001**	**1.00**	**<0.001**
Median Household Income (per $10000)	**0.90**	**<0.001**	**1.00**	**<0.001**
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**2.93**	**<0.001**	**0.99**	**<0.001**
Labor Force Participation Rate (per 10%)	**9.25**	**<0.001**	**0.97**	**<0.001**
Gini Income Inequality Coefficient (per 1%)	**0.77**	**<0.001**	**2.15**	**<0.001**
Vacant Houses (per 100)	**1.63**	**<0.001**	**1.00**	**<0.001**
Spatial Lag				
White Population Percentage (per 10%)	**1.48**	**<0.001**		
Median Household Income (per $10000)	**0.87**	**<0.001**		
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**1.47**	**<0.001**		
Labor Force Participation Rate (per 10%)	**17.18**	**<0.001**		
Gini Income Inequality Coefficient (per 1%)	**0.83**	**<0.001**		
Vacant Houses (per 100)	**1.20**			
County	**0.81**	**<0.001**		

Table 3.17: Spatial Lag Covariate Interaction Regression Model Coefficients in Western Maryland Compared to Lower Eastern Shore, Maryland – 2011-2015

Variable	Multivariate Model			
	Focal & Spatial Lag		Focal & Spatial Lag Interaction	
	Exponentiated Beta	p-value	Exponentiated Beta	p-value
Focal Effects				
White Population Percentage (per 10%)	**0.59**	**<0.001**	**1.00**	**<0.001**
Median Household Income (per $10000)	**0.50**	**<0.001**	**1.00**	**<0.001**
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**0.33**	**<0.001**	**1.05**	**<0.001**
Labor Force Participation Rate (per 10%)	**30.02**	**<0.001**	**0.95**	**<0.001**
Gini Income Inequality Coefficient (per 1%)	**0.29**	**<0.001**	**24.78**	**<0.001**
Vacant Houses (per 100)	**0.99**	**<0.001**	**1.00**	**<0.001**
Spatial Lag				
White Population Percentage (per 10%)	**0.33**	**<0.001**		
Median Household Income (per $10000)	**0.60**	**<0.001**		
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**0.36**	**<0.001**		
Labor Force Participation Rate (per 10%)	**49.65**	**<0.001**		
Gini Income Inequality Coefficient (per 1%)	**0.25**	**<0.001**		
Vacant Houses (per 100)	**0.96**			

Table 3.18: Spatial Lag Covariate Interaction Regression Model Coefficients in Baltimore County, Maryland Compared to Howard County, Maryland – 2011-2015

Variable	Multivariate Model			
	Focal & Spatial Lag		Focal & Spatial Lag Interaction	
	Exponentiated Beta	p-value	Exponentiated Beta	p-value
Focal Effects				
White Population Percentage (per 10%)	**0.99**	**<0.01**	**1.00**	**<0.001**
Median Household Income (per $10000)	**0.88**	**<0.001**	**1.00**	**<0.001**
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**1.12**	**<0.001**	**1.00**	**<0.001**
Labor Force Participation Rate (per 10%)	**30.91**	**<0.001**	**0.95**	**<0.001**
Gini Income Inequality Coefficient (per 1%)	**0.84**	**<0.001**	**1.72**	**<0.001**
Vacant Houses (per 100)	**0.92**	**<0.001**	**1.00**	**<0.001**
Spatial Lag				
White Population Percentage (per 10%)	**0.86**	**<0.001**		
Median Household Income (per $10000)	**0.80**	**<0.001**		
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**1.09**	**<0.001**		
Labor Force Participation Rate (per 10%)	**28.47**	**<0.001**		
Gini Income Inequality Coefficient (per 1%)	**0.79**	**<0.001**		
Vacant Houses (per 100)	**1.30**	**<0.001**		
County	**0.38**	**<0.001**		

Chapter 4: The relationships between racial concentration and neighborhood-level tobacco outlet density in Maryland jurisdictions with similar socioeconomic status

Abstract

Introduction: Race has been shown to be a social construct, but its effects on health disparities and resource inequalities is substantial due to systems of oppression like segregation. Tobacco outlet density studies have reported a direct relationship between Black population percentage and tobacco outlet density, as well as inverse relationships between socioeconomic status and tobacco outlet density. It remains unclear whether socioeconomic status or race has a larger effect than the other. This study compared predominantly-Black and predominantly-White Maryland areas with similar socioeconomic status to examine the role of both race and socioeconomic status on tobacco outlet availability and tobacco outlet access. Influence by Fakunle and colleagues (2016), the hypothesis was that there would be no difference in tobacco outlet availability and access in areas with similar socioeconomic status despite different majority racial concentrations. Methods: This study utilized tobacco outlet license data from the Maryland State Licensing Bureau, geocoded the addresses via the State of Maryland's Mapping and GIS Data Portal, and combined the addresses with 2011-2015 American Community Survey demographic data. Two-sample t-tests were conducted compare the mean values of sociodemographic variables and tobacco outlet density per Census Tract of the study areas, and spatial lag models were conducted to analyze the direct association between covariates and tobacco outlet density while accounting for spatial dependence between and within jurisdictions. Results: Two-sample t-tests results showed that predominantly-White jurisdictions had lower tobacco outlet availability and access than predominantly-Black jurisdictions, despite similar socioeconomic status. Spatial lag model results showed that median household income and

vacant houses had consistent associations with tobacco outlet density across most of the jurisdictions analyzed, and place-based spatial lag models showed direct associations between predominantly-Black jurisdictions and tobacco outlet availability and access. Discussion: Study results suggest that similar socioeconomic status does not remove racial differences in tobacco outlet availability and access, and that contextual and historical understanding of racial systems of oppression must be acknowledged to fully explain place-based disparities. Additionally, study results corroborate findings from Aim I that median household income appears to be the most consistent predictor of tobacco outlet density among socioeconomic status measures, when compared to income inequality, educational attainment, vacant housing, and other measures.

Introduction

It has been established that race is a social construct with no concrete biological or genetic basis by which to designate various groups (Smedley and Smedley, 2005; Lopez, 1994; Williams, 1997). However, systems of oppression such as racism (Gaskin et. al, 2005; Williams et. al, 1994) and discriminatory policies like slavery, segregation and redlining (Oliver & Shapiro, 2006; Thorpe et. al, 2017; Eisenhauer, 2001; Williams & Collins, 2001) have made race a considerable determinant of social outcomes in U.S. society including income, wealth, housing, employment, criminal justice, and health. The historical implementation of systems of oppression has resulted in an intertwining of race and socioeconomic status, and while many of these policies are no longer used, at least overtly, their ramifications continue. Inequalities in socioeconomic status by race are so pronounced that it is implied that Blacks are in a lower socioeconomic status (LaVeist, 2005; Williams, 1999). The intertwining of race and socioeconomic status must be acknowledged and addressed in tobacco outlet density research studies involving the constructs. However, the field must first produce a strong epidemiological

foundation of racial and socioeconomic determinants of tobacco outlet density before moderation of race and socioeconomic status should be considered. Tobacco outlet density research has reported relationships between racial composition and the availability and access to tobacco retailers, specifically a direct relationship between the percentage of Blacks and Latinos living in an area and tobacco outlet density (Peterson et. al, 2005; Hyland et. al, 2003; Fakunle et. al, 2010) and an inverse relationship between the percentage of Whites living in an area and tobacco outlet density (Novak et. al, 2006; Lee et. al, 2017). Likewise, tobacco outlet density research has reported inverse relationships between an area's socioeconomic composition and the availability and access to tobacco retailers (Peterson et. al, 2005; Hyland et. al, 2003; Schneider et. al, 2005; Fakunle et. al, 2010; Fakunle et. al, 2016). However, it is still not clear if either race or socioeconomic status matters more in the association with tobacco availability and access. In examining the relationship between race, socioeconomic status and tobacco outlet density, restriction, stratification and randomization are just a few of the ways that research studies can address confounding and contribute insight to explaining epidemiological relationships (Kestenbaum, 2009). Most tobacco outlet density studies have utilized regression analyses, a post-hoc methodology, to control for confounding and explain the relationship between sociodemographics and tobacco outlet density. Regression analyses have been successful in providing some understanding of how race and socioeconomic status relate to tobacco outlet density (Fakunle et. al, 2010; Rodriguez et. al, 2012; Fakunle et. al, 2016; Lee et. al, 2017). However, tobacco outlet density research would benefit from utilizing other techniques to elaborate on the association with sociodemographics from different perspectives. Neighborhood components such as racial composition and socioeconomic status metrics can provide more detail as to how they relate to tobacco outlet density if they are thoroughly explored as the

essential elements of a social-geographic environment that they are. Most tobacco outlet density studies have focused on one geographic area or assemblage of areas (Hyland et. al, 2003; Peterson et. al, 2005; Schneider et. al, 2005; Mayers et. al, 2012). A common recommendation of tobacco outlet density researchers is the establishment of policy reform to reduce racial and socioeconomic inequalities in tobacco access and availability (Peterson et. al, 2005; Fakunle et. al, 2010; Lee et. al, 2017). While there are many factors that affect the success of a policies, such as its enforcement, it is possible that one of the explanations behind the lack of proactive tobacco outlet policy is that the interpretations and patterns reported in tobacco outlet density studies have not been generalized beyond the study locale, particularly if the area exhibits sociodemographic homogeneity (Rbisil, et. al, 2016). Therefore, the results reported are interpreted as a phenomenon reflective of the study area. To address this concern, one of the next steps that has been taken in tobacco outlet density research is the comparison of sociodemographic relationships across multiple areas that match or differ based on one or more discernable characteristics. The comparisons of areas and their tobacco outlet densities provide a different perspective of how area compositions and population dynamics affect relationships with tobacco outlet density – specifically, a perspective of relativity (Fakunle et. al, 2010; Fakunle et. al, 2016). This study and Aim I were intended to provide a more comprehensive examination of the relationship between race, socioeconomic status and tobacco outlet density, which can inform and guide both future tobacco outlet density research and more proactive tobacco outlet control policies. The utilization of matching and comparisons have allowed studies to show the patterns associated between socioeconomic status and tobacco outlet density within areas of similar racial concentrations (Fakunle et. al, 2016), and this study utilized the same methodologies. However, the goal was to parse out effects of racial concentration on

tobacco outlet density among areas with similar magnitudes of socioeconomic status. Using jurisdictions in Maryland, this study compared areas with high-Black and high-White population percentages to determine if either or both racial concentrations correlated with tobacco outlet density despite the jurisdictions being socioeconomically comparable. Influenced by results from Fakunle and colleagues (2016), the hypothesis was that there would be no differences in tobacco outlet availability and access among jurisdictions with similar socioeconomic status despite different majority racial concentrations. Additionally, influenced by results from Aim I, it was hypothesized that median household income would be the most consistent predictor of tobacco outlet density and access. However, urbanicity is a potential confounder of racial differences between predominantly-White and predominantly-Black areas. Urbanicity has been addressed in studies that examined place-based disparities (Barnett & Halverson, 2000; Bower et. al, 2014), but the association between urbanicity and tobacco outlet density has not been adequately researched. Rodriguez and colleagues (2012) reported that poverty, regardless of urban or rural location, was a consistent predictor of tobacco outlet density. Based on that report it was reasonable to hypothesize that areas with no difference in median household income would correlate with no differences in tobacco outlet density despite comparing more rural jurisdictions to more urban areas. While the findings by Rodriguez and colleagues (2012) suggested this was not a concern, acknowledgement of other urban-rural differences should not be disregarded, like access to resources and population scarcity (Duncan, 2000; Hartley, 2004). The overall goal of this study was to disentangle the complex relationship between race and socioeconomic status and better understand how upstream factors like race and socioeconomic status influence tobacco outlet availability and access within and across locales. Therefore, to acknowledge potential urban-rural differences in tobacco outlet availability and access, this study utilized two different

measures of tobacco outlet density after preliminary analyses of Maryland jurisdictions concluded that the only way to compare predominantly-Black jurisdictions and predominantly-White jurisdictions with similar median household income would be to compare predominantly-urban areas to predominantly-rural areas. For availability, tobacco outlet density was measured as the number of tobacco outlets per 1,000 persons per Residential Census Tract, consistent with Fakunle and colleagues (2016). For access, tobacco outlet density was measured as the number of tobacco outlets per 10km of roadway, consistent with past tobacco outlet density studies (Schneider et. al, 2005; Fakunle et. al, 2010; Peterson et. al, 2011; Reid et. al, 2013).

Methods

Census Tract demographic data were obtained from the 2011-2015 American Community Survey (ACS), made available via the United States Census website. The American Community Survey, inaugurated in 2005, is a perennial survey administered by the U.S. Census Bureau that acquires data on the sociodemographic dynamics of people living in the United States (U.S. Census Bureau, 2016). The five-year pooled estimate of sociodemographic data was preferred over the one-year and three-year pooled estimates because of the larger dataset that included data for all areas, thus allowing for examination of small Residential Census Tracts, and greater reliability. Of the 1,406 Census Tracts in Maryland, 18 had a total population of less than 600 persons and consistent with the methodology from Fakunle et. al (2016) were excluded from analyses. The exclusion resulted in a final total of 1,388 included in the analyses. Maryland tobacco outlet data – including retailer names, contact information and retail/mailing locations – were obtained from the Maryland State Licensing Bureau, which provided the addresses for retailers with an active Cigarette, Special Cigarette, Other Tobacco Product (OTP) or Tobacconist licenses as of April 30, 2017. The sale of loose cigarettes in prohibited by Maryland state law, although licensed retailers may engage in the activity (Smith et. al, 2007). Tobacco

outlet retail addresses were geocoded via MD iMap – the State of Maryland's Mapping and GIS Data Portal – the most current publicly available geocoding service for the state. Of the addresses provided (n = 2,851), only five needed to be modified: one determined to be a duplicate (deleted), one determined to be out-of-state (Florida) with no alternative address given (deleted), one determined to have two adjacent addresses (second address added), one determined to be closed (deleted), and one geocoded with the mailing address due to the outlet being a food truck. Most of the licensed tobacco outlets were successfully geocoded after the first iteration. Of the revised total addresses (n = 2,849), all but 144 were successfully geocoded via the Batch Address Look-Up service. The 144 entries that did not return a geocode were cross-referenced with Google Maps and other internet-based resources (e.g., retailer websites) to verify the correct address. After verification, the addresses were re-run via the Single Address Look-Up service of which all but 19 were successfully geocoded. In total, 2,830 of the 2,849 addresses (99.3%) were successfully geocoded. The addresses were then merged with Maryland sociodemographic data via the Spatial Join tool in ArcGIS. It was then determined that a total of 3 tobacco outlets were located among the 18 Census Tracts excluded from analyses. Eight variables measuring racial composition, socioeconomic status and built environment were selected from the ACS dataset. The expansion of socioeconomic covariates beyond the study of two predominantly-Black locales in Maryland by Fakunle and colleagues (2016) was to provide a more thorough understanding of the relationship between socioeconomic status, race and tobacco outlet density beyond one measure – median household income (Mayers et. al, 2012; Rodriguez et. al, 2012; Lee et. al, 2017). Additionally, the expansion of socioeconomic covariates aimed to address the lack of consideration in research for income inequality's influence in health disparities (Kawachi & Kennedy, 1999; Subramanian & Kawachi, 2004; Fakunle et. al, 2010). The measures included

in the study were the total population, the total number of individuals who identify as Black or African American (converted to a percentage), the total number of individuals who identify as White (converted to a percentage), the percentage of individuals 25 years and over who have obtained at least a Bachelor's degree, the Gini index of income inequality (presented as a coefficient), the total number of vacant housing units, the total number of individuals 16 years and older who are actively in the labor force (converted to a percentage), and median household income, expressed in 2015 inflation-adjusted dollars. Residential Census Tracts have been the prevailing spatial unit of measurement in tobacco outlet density research, yet other spatial units have been utilized in tobacco outlet density studies such as census block groups, which are smaller and more refined than Residential Census Tracts (Reid et. al, 2005; Ogneva-Himmelberger et. al, 2010). Similar research in alcohol outlet density have also used census block groups as the spatial unit of measurement (Gorman et. al, 2001; Morrison et. al, 2016; Grubesic et. al, 2016). While there is no consensus unit of measurement, Residential Census Tracts are the most frequently used. Census block groups, while more refined than Residential Census Tracts, have more variation which can lead to analytical instability. Likewise, analyses of broad jurisdictions like cities, counties or states may lead to results that do not allow for inference (Yu et. al, 2010). Therefore, Residential Census Tracts are currently the best spatial units that both exude distinct neighborhood characteristics yet provide manageable data and potentially generalizable analysis results.

Statistical Analyses

Two-sample t-tests were conducted to compare the mean values per Census Tract of the study areas and provide a baseline measure of differences in tobacco outlet density and sociodemographic characteristics across areas. The two-sample t-tests were conducted via the

SPSS statistical package. Spatial lag Poisson models were conducted to show the individual and collective effects of the sociodemographic covariates on tobacco outlet density both within and across jurisdictions. Jurisdictions that were compared to each other in the two-sample t-tests were then compared to each other in place-based interaction Poisson models. These were conducted to determine if there were differences in the magnitude of relationship between covariates and tobacco outlet density based on location. The covariates were spatially lagged, meaning that the models included coefficients for the covariate in the immediate, proximal Census Tracts (focal effects) and the extended, distal environment around Census Tracts (spatial lag effects). To conduct spatial analyses of social factors and tobacco outlet density, neighborhood structures were created. In spatial statistics, a neighborhood structure is an arrangement of spatial data and in this study, an arrangement of tobacco outlet and sociodemographic data (Fischer & Gettis, 2013). For this analysis and to best adjust for spatial dependence, a "neighborhood" was defined as a Census Tract that shared at least more than one boundary with another Census Tract. Weight matrices – quantified representations of spatial relationships – were then created based on the neighborhood structures. The Census Tracts and sociodemographics data for each Tract provided the features needed to create the matrices. After the creation of the weight matrices, spatial smoothing was conducted to assure more consistent outcomes tobacco outlet density measures across the established Census Tracts. Spatial smoothing is a technique that aggregated the sociodemographic and tobacco outlet data across polygons (Census Tracts) to create more robust estimates and improve accuracy (Auchincloss et. al, 2012). The spatial smoothing was based on population, so areas with a higher population were weighted more heavily than area with a lower population. After spatial smoothing, Moran's I was tested to determine whether jurisdictions exhibited spatial dependence. Moran's I is a

correlation coefficient, ranging from -1 to 1, that measures the extent of spatial dependence. A coefficient closer to 1 indicates similarity between adjacent areas, a coefficient closer to -1 indicates dissimilarity between adjacent areas, and a coefficient closer to zero indicates no correlation between adjacent areas (Statistics How To, 2017). All spatial analyses were conducted via the RStudio software package. Four models were conducted for each study area: a univariate model for each covariate, a multivariate model for focal effect covariates, a multivariate model for focal effect and spatially lagged covariates, and a multivariate model for focal effect and spatially lagged covariates, and interaction terms between the focal effect and spatially lagged covariates. Exponentiated beta coefficients were reported and magnified for easier interpretation. Due to the high number of significant coefficients in the models, the results section highlights focal effect and/or spatially lagged covariates that exhibited a consistent relationship (direct or inverse) across all four models. Chi-square statistics were conducted to determine the extent of overdispersion, or presence of greater variability, in the final model compared to the null model. Overdispersion occurs when the observed variance is greater than the theoretical variance, which is tied to the mean in Poisson models, and this indicates how much the models explain the variance of tobacco outlet density. The higher or lower the chi-square statistic, the more or less data are overdispersed.

Study Areas

The following jurisdictions were chosen for inclusion in this study based on preliminary examination of Black population percentage, White population percentage and median household income. Baltimore City is in northeast Maryland had 199 Census Tracts, was predominantly Black (~65%), and had an average median household income totaling $44,264. Baltimore County is in northeast Maryland, had 211 Census Tracts was predominantly White

(~66%), and had an average median household income totaling $73,114. Lower Eastern Shore (Dorchester County, Somerset County, Wicomico County and Worcester County) is in southern Maryland, had 50 Census Tracts, was predominantly White (~72%), and had an average median household income totaling $49,470. Prince George's County is in south-central Maryland, had 218 Census Tracts, was predominantly Black (~67%), and had an average median household income totaling $77,378. Western Maryland (Allegany County, Garrett County and Washington County) is in western Maryland, had 62 Census Tracts, was predominantly White (~87%), and had an average median household income totaling $48,164. For reference, the Black population percentage for the state of Maryland was 29.5%, the White population percentage for the state of Maryland was 57.6% and the median household income totaled $74,551.

Results

Descriptives – Prince George's County and Baltimore County

Prince George's County, a predominantly-Black jurisdiction, had a statistically significantly higher labor force participation rate and lower income inequality coefficient than Baltimore County. Baltimore County, a high-White jurisdiction, had a statistically significantly higher percentage of individuals aged 25 years and older with at least a Bachelor's degree. Despite no significant differences median household income, population, and vacant houses, Prince George's County had statistically significantly higher tobacco outlet access and tobacco outlet availability than Baltimore County (see Table 4.1).

Descriptives – Baltimore City and Western Maryland

Baltimore City, a predominantly-Black jurisdiction, had statistically significantly percentage of individuals aged 25 years and older with at least a Bachelor's degree than Western Maryland. Population, vacant houses and median household income exhibited no statistical

differences. Western Maryland, a predominantly-White region, had a statistically significantly larger population and significantly lower income inequality. Despite no significant differences in median household income, labor force participation rate and number of vacant houses, Baltimore City had statistically significantly higher tobacco outlet access and tobacco outlet availability than Western Maryland (see Table 4.2).

Descriptives – Lower Eastern Shore and Baltimore City

Lower Eastern Shore, a predominantly-White region, had a statistically significantly larger population and number of vacant houses, and significantly lower income inequality than Baltimore City. Despite no significant differences in median household income, percentage of individuals aged 25 years and older with at least a Bachelor's degree and labor force participation rate, Baltimore City, a predominantly-Black jurisdiction, had statistically significantly higher tobacco outlet access and tobacco outlet availability than Lower Eastern Shore (see Table 4.3).

Moran's I

As in Aim I, Moran's I was tested to determine the extent of spatial dependence in the State of Maryland and the individual jurisdictions that were examined. The coefficient was tested with both the number of tobacco outlets and the number of tobacco outlets per 1,000 persons per Census Tract as outcomes. For Lower Eastern Shore and Western Maryland, Moran's I was tested on the counties that constitute both regions. The results showed that Baltimore City exhibited spatial dependence based on count ($I = 0.13$, $p = 0.001$) and tobacco outlet density ($I = 0.25$, $p = 0.001$). Baltimore County did not exhibit spatial dependence based on count ($I = 0.05$, $p = 0.10$) or tobacco outlet density ($I = 0.02$, $p = 0.25$). Allegany County ($I = -0.14$, $p = 0.78$ for count; $I = -0.14$, $p = 0.80$ for tobacco outlet density), Garrett County ($I = -0.003$, $p = 0.16$ for

count; I = -0.18, p = 0.52 for tobacco outlet density), and Washington County (I = -0.15, p = 0.86 for count; I = -0.05, p = 0.54 for tobacco outlet density) – the three counties that comprise Western Maryland – did not exhibit spatial dependence. With the exception of Wicomico County based on tobacco outlet density (I = 0.22, p = 0.01), Lower Eastern Shore – Somerset County (I = 0.01, p = 0.18 for count), Wicomico County (I = 0.13, p = 0.06 for tobacco outlet density), Worcester County (I = 0.03, p = 0.19 based on count; I = -0.02, p = 0.33 based on tobacco outlet density), and Dorchester County (I = -0.08, p = 0.36 based on count; I = -0.04, p = 0.25 based on tobacco outlet density) – did not exhibit spatial dependence. Prince George's County did not exhibit spatial dependence based on count (I = -0.0003, p = 0.45) or tobacco outlet density (I = 0.06, p = 0.06). However, because Maryland exhibited spatial dependence based on count (I = 0.40, p = 0.001) and tobacco outlet density (I = 0.51, p = 0.001), spatial lag modeling was conducted due to the state's inclusion of 24 jurisdictions, including the study areas.

Univariate and Multivariate Spatial Lag Models

As in Aim I, univariate and multivariate spatial lag models were conducted to examine the unadjusted and adjusted relationships between race, socioeconomic status and tobacco outlet density in both proximal Census Tracts and distal Census Tract neighborhoods (Fakunle et. al, 2016). Again, due to the high number of significant coefficients in the models, results highlighted focal effect and/or spatially lagged covariates that exhibited a consistent relationship (direct or inverse) across all four models.

Prince George's County – Tobacco Outlet Availability

In Prince George's County, there was an inverse relationship between the percentage of individuals aged 25 years and older with at least a Bachelor's degree and tobacco outlet availability within proximal Census Tracts and distal Census Tract neighborhoods, an inverse

relationship between median household income and tobacco outlet availability within distal Census Tract neighborhoods, and an inverse relationship between labor force participation rate and tobacco outlet availability within distal Census Tract neighborhoods. Conversely, there was direct relationship between income inequality and tobacco outlet availability within both proximal Census Tracts and distal Census Tract neighborhoods, and a direct relationship between vacant houses and tobacco outlet availability within distal Census Tract neighborhoods (see Table 4.4 and 4.5). Chi-square statistics showed a reduction in overdispersion between the null model ($\chi 2 = 587{,}896.5$) and final model ($\chi 2 = 454{,}750.5$).

Prince George's County – Tobacco Outlet Access

In Prince George's County, there was an inverse relationship between the percentage of individuals aged 25 years and older with at least a Bachelor's degree and tobacco outlet access within proximal Census Tracts and distal Census Tract neighborhoods, an inverse relationship between Black population percentage and tobacco outlet access within distal Census Tract neighborhoods, and an inverse relationship between median household income and tobacco outlet access within distal Census Tract neighborhoods. Conversely, there was a direct relationship between income inequality and tobacco outlet access within proximal Census Tracts and distal Census Tract neighborhoods (see Table 4.6 and 4.7). Chi-square statistics showed a reduction in overdispersion between the null model ($\chi 2 = 8{,}851{,}322$) and final model ($\chi 2 = 4{,}974{,}578$).

Baltimore City – Tobacco Outlet Availability

In Baltimore City, there was an inverse relationship between the percentage of individuals aged 25 years and older with at least a Bachelor's degree and tobacco outlet availability within proximal Census Tracts and distal Census Tract neighborhoods. Conversely,

there was direct relationship between vacant houses and tobacco outlet availability within both proximal Census Tracts and distal Census Tract neighborhoods (see Table 4.8 and 4.9). Chi-square statistics showed a reduction in overdispersion between the null model ($\chi 2$ = 1,633,677) and final model ($\chi 2$ = 1,092,101).

Baltimore City – Tobacco Outlet Access

In Baltimore City, there was an inverse relationship between the percentage of individuals aged 25 years and older with at least a Bachelor's degree and tobacco outlet access within proximal Census Tracts and distal Census Tract neighborhoods. Conversely, there was direct relationship between vacant houses and tobacco outlet access within both proximal Census Tracts and distal Census Tract neighborhoods (see Table 4.10 and 4.11). Chi-square statistics showed a reduction in overdispersion between the null model ($\chi 2$ = 14,684,742) and final model ($\chi 2$ = 8,864,909).

Western Maryland – Tobacco Outlet Access

In Western Maryland, there was an inverse relationship between median household income and tobacco outlet access within proximal Census Tracts, and an inverse relationship between vacant houses and tobacco outlet access within proximal Census Tracts. Conversely, there was direct relationship between income inequality and tobacco outlet access within both proximal Census Tracts and distal Census Tract neighborhoods, and a direct relationship between labor force participation rate and tobacco outlet access within distal Census Tract neighborhoods (see Table 4.12 and 4.13). Chi-square statistics showed a reduction in overdispersion between the null model ($\chi 2$ = 1,535,059) and final model ($\chi 2$ = 462,793.6).

Lower Eastern Shore – Tobacco Outlet Access

In Lower Eastern Shore, there was direct relationship between labor force participation

rate and tobacco outlet access within distal Census Tract neighborhoods (see Table 4.14 and 4.15). Chi-square statistics showed a reduction in overdispersion between the null model ($\chi 2$ = 6,600,479) and final model ($\chi 2$ = 1,433,631).

Baltimore County – Tobacco Outlet Access

In Baltimore County, there was an inverse relationship between median household income and tobacco outlet access within proximal Census Tracts and distal Census Tract neighborhoods, an inverse relationship between the percentage of individuals aged 25 years and older with at least a Bachelor's degree and tobacco outlet access within proximal Census Tracts, an inverse relationship between White population percentage and tobacco outlet access within distal Census Tract neighborhoods, and an inverse relationship between income inequality and tobacco outlet access within distal Census Tract neighborhoods. Conversely, there was a direct relationship between vacant houses and tobacco outlet access within distal Census Tract neighborhoods (see Table 4.16 and 4.17). Chi-square statistics showed a reduction in overdispersion between the null model ($\chi 2$ = 4,865,679) and final model ($\chi 2$ = 2,563,370).

Place-Based Interaction Models

As in Aim I, place-based interaction Poisson models were conducted to determine if there were differences in the relationships between sociodemographic covariates and tobacco outlet density based on location. Except for comparisons involving Western Maryland and Lower Eastern Shore, the jurisdiction with the lower tobacco outlet density was set as the reference variable. Again, covariates that exhibited a consistent relationship (direct or inverse) among both focal effects and spatial lag effects were reported.

Prince George's County – Baltimore County (Availability)

There were differences in the magnitude of relationships between sociodemographic

covariates and tobacco outlet availability in Prince George's County when compared to Baltimore County. Except for median household income and number of vacant houses, there were differences in SES measures and tobacco outlet availability and access. In Prince George's County, a predominantly-Black jurisdiction, there was a direct relationship between labor force participation rate and tobacco outlet availability and a direct relationship between income inequality and tobacco outlet availability. The strongest relationship with tobacco outlet availability was a direct relationship labor force participation rate and tobacco outlet availability in proximal Census Tracts, followed by a direct relationship between labor force participation rate and tobacco outlet availability in distal Census Tracts neighborhoods (see Table 4.18).

Prince George's County – Baltimore County (Access)

There were differences in the magnitude of relationships between sociodemographic covariates and tobacco outlet access in Prince George's County when compared to Baltimore County. In Prince George's County, there was an inverse relationship between median household income and tobacco outlet access, an inverse relationship between labor force participation rate and tobacco outlet access, and an inverse relationship between income inequality and tobacco outlet access. The strongest relationship with tobacco outlet access was an inverse relationship between median household income and tobacco outlet access in distal Census Tract neighborhoods, followed by an inverse relationship between labor force participation rate and tobacco outlet access in distal Census Tracts neighborhoods (see Table 4.19).

Western Maryland – Baltimore City (Availability)

There were differences in the magnitude of relationships between sociodemographic covariates and tobacco outlet availability in Western Maryland when compared to Baltimore City. Except for median household income, labor force participation rate and number of vacant

houses, there were differences in SES measures and tobacco availability and access. In Western Maryland, a predominantly-White region, there was an inverse relationship between the percentage of individuals aged 25 years and older with at least a Bachelor's degree and tobacco outlet availability, and an inverse relationship between income inequality and tobacco outlet availability. Conversely, there was a direct relationship between median household income and tobacco outlet availability and a direct relationship between vacant houses and tobacco outlet availability. The strongest relationship with tobacco outlet availability was a direct relationship between vacant houses and tobacco outlet availability in proximal Census Tracts, followed by a direct relationship between vacant houses and tobacco outlet access in distal Census Tracts neighborhoods (see Table 4.20).

Western Maryland – Baltimore City (Access)

There were differences in the magnitude of relationships between sociodemographic covariates and tobacco outlet access in Western Maryland when compared to Baltimore City. In Western Maryland, there was an inverse relationship between the percentage of individuals aged 25 years and older with at least a Bachelor's degree and tobacco outlet access, an inverse relationship between labor force participation rate and tobacco outlet access and an inverse relationship between income inequality and tobacco outlet access. Conversely, there was a direct relationship between median household income and tobacco outlet access and a direct relationship between vacant houses and tobacco outlet access. The strongest relationship with tobacco outlet access was a direct relationship between vacant houses and tobacco outlet access in proximal Census Tracts, followed by a direct relationship between vacant houses and tobacco outlet access in distal Census Tracts neighborhoods (see Table 4.21).

Lower Eastern Shore – Baltimore City (Availability)

There were differences in the magnitude of relationships between sociodemographic covariates and tobacco outlet availability in Lower Eastern Shore when compared to Baltimore City. Except for median household income, the percentage of individuals aged 25 years and older with at least a Bachelor's degree and labor force participation rate, there were differences in SES measures and tobacco outlet availability and access. In Lower Eastern Shore, a predominantly-White region, there was an inverse relationship between the percentage of individuals aged 25 years and older with at least a Bachelor's degree and tobacco outlet availability, an inverse relationship between labor force participation rate and tobacco outlet availability, and an inverse relationship between income inequality and tobacco outlet availability. Conversely, there was a direct relationship between median household income and tobacco outlet availability and a direct relationship between vacant houses and tobacco outlet availability. The strongest relationship with tobacco outlet availability was an inverse relationship between income inequality and tobacco outlet availability in distal Census Tract neighborhoods, followed by an inverse relationship between the percentage of individuals aged 25 years and older with at least a Bachelor's degree and tobacco outlet availability in proximal Census Tracts (see Table 4.22).

Lower Eastern Shore – Baltimore City (Access)

There were differences in the magnitude of relationships between sociodemographic covariates and tobacco outlet access in Lower Eastern Shore when compared to Baltimore City. In Lower Eastern Shore, there was an inverse relationship between the percentage of individuals aged 25 years and older with at least a Bachelor's degree and tobacco outlet access, an inverse relationship between labor force participation rate and tobacco outlet access, and an inverse relationship between income inequality and tobacco outlet access. Conversely, there was a direct relationship between median household income and tobacco outlet access and a direct

relationship between vacant houses and tobacco outlet access. The strongest relationship with tobacco outlet access was an inverse relationship between labor force participation rate and tobacco outlet access in proximal Census Tracts, followed by an inverse relationship between labor force participation rate and tobacco outlet access in distal Census Tract neighborhoods (see Table 4.23).

Discussion

The aim of this study was to compare tobacco outlet availability and tobacco outlet access in predominantly-Black areas and predominantly-White areas with similar socioeconomic status to determine if either or both racial concentrations correlated with tobacco outlet density despite the jurisdictions being socioeconomically similar. The first key finding is that the descriptives conducted in this study revealed findings that add a dynamic to consider in the relationship between racial concentration, socioeconomic status and tobacco outlet density, but did not support the hypothesis. Contrary to the hypothesis, predominantly-White jurisdictions consistently had lower tobacco outlet availability and tobacco outlet access than predominantly-Black jurisdictions, despite similar socioeconomic status. Results of the place-based interaction Poisson models further supported a rejection of the hypothesis by showing that location affected the relationship between sociodemographics and tobacco outlet availability and access while accounting for socioeconomic status. For example, Prince George's County, a predominantly-Black jurisdiction, had a statistically significant direct relationship, with a magnitude different than 1, with both tobacco outlet availability and tobacco outlet access when Baltimore County was set as the reference variable. The collective findings suggest that socioeconomic status, even when similar, does not remove racial differences in tobacco outlet availability and access. The second key finding was that median household income, whether in proximal Census Tracts

and/or distal Census Tract neighborhoods, exhibited a consistent inverse association with tobacco outlet availability and access in three of the five study areas and 11 of the 20 total spatial models. This is consistent with the findings of Aim I, which also reported a consistent inverse relationship with tobacco availability in most of the spatial analyses. Additionally, there was a consistent direct relationship between vacant houses and tobacco outlet availability and access in most of the study areas, and this finding supports findings reported by Lee and colleagues (2017).

LaVeist and colleagues showed in their Exploring Health Disparities in Integrated Communities (EHDIC) study that racial differences in health outcomes exist between Black and White populations that live within the same socioeconomic circumstances. It is only after adjusting for race that most disparities between the two racial groups are mitigated or eliminated, but even then, some remain (LaVeist et. al, 2011). Similar results were seen after analyses of tobacco outlet availability and tobacco outlet access in predominantly-White and predominantly-Black locales with similar socioeconomic status, which suggests that tobacco control policies should be sensitive to racial gradients in addition to socioeconomic gradients. Specifically, predominantly-Black neighborhoods may experience higher concentrations of tobacco outlets than predominantly-White neighborhoods, even if the socioeconomic status of both neighborhoods are similar. The indication from LaVeist and colleagues is that the connotation of racial health disparities must be interpreted through the lens of institutional racism – in the case of the EHDIC study, segregation. This indication is encouraged by other health disparities studies (Williams & Collins, 2001; LaVeist, 2005; Williams et. al, 2010; Thorpe et. al, 2017) The results of this study encourage a similar connotation when explaining the relationship between race, socioeconomic status and tobacco outlet availability and access. What was shown

was that predominantly-Black locales with similar socioeconomic status to their predominantly-White counterparts may not be afforded systemic protective factors against tobacco outlet availability and access.

The results of this study contribute to the knowledge of place-based disparities and how disparities in tobacco outlet availability and access are related to race, particularly the relationship between higher Black populations and greater availability and access to tobacco outlets. One explanation of these relationships is the history of Blacks and social mobility in the United States (Trotter, 1991; Tolnay, 2003; Lemann, 2011). The history of Black social mobility begins with the kidnapping and enslavement of millions of Africans, and their dispersal around the world, including what would become the United States. After the Emancipation Proclamation, formerly enslaved Blacks were relegated to a newer form of slavery, sharecropping. However, during this period, some Blacks created their own jurisdictions and institutions, but domestic terrorism soon destroyed any semblance of equality and was quickly followed by laws assuring that the rebuilding of Black establishments was near-impossible. Worsening conditions, particularly in the South, led to the Great Migration in which 6 million Blacks moved primarily to the North and Midwest. While opportunity for social mobility was relatively better than where they left, many Blacks faced equally difficult oppression. Many jurisdictions, in response to the growing number of Black residents, enacted racist laws to severely restrict what employment they could secure and where they could live among other limitations. Baltimore, one of the notable urban cities to do so, is considered by many historians to be the archetype of modern institutional racism with its institution of policies such as redlining and Black codes. Federal policies such as the National Interstate and Defense Highways Act in 1956 led to mass exodus of Whites and their economic bases into the suburbs, leaving many

Blacks and other non-White populations to deal with crumbling urban infrastructures and a weakened economic base. While later advances in civil rights led to a quantum leap in educational and economic opportunities for many Blacks, it has yet to fully reverse the lingering residuals of systemic disadvantage that continue to plague many urban metropolitan locales, and in many urban areas it has worsened. It is beyond the reach of this study to make a definitive statement as to whether predominantly-Black areas are specifically targeted with greater availability of tobacco outlets or if Blacks are more likely to live in areas with higher tobacco outlet density. However, research has provided evidence of the tobacco industry's target marketing of Black communities using point-of-sale advertising and advertising in various publications (Moore et. al, 1996; King et. al, 2001; Laws et. al, 2002; Landrine et. al, 2004; Alpert et. al, 2008). Therefore, it is plausible that the tobacco industry may encourage more businesses to sell tobacco products in Black communities than they encourage to sell in White communities, regardless of the socioeconomic status of either community, given the additional stressors suffered by Blacks that may promote unhealthy coping mechanisms such as tobacco use (Clark et. al, 1999; Harrell, 2000; Brondolo et. al, 2009).

As in Aim I, context is important in understanding the complex relationship between race and socioeconomic status. While multiple measures of SES were analyzed and did explain some of the spatial variation in tobacco outlet availability and access across the study areas as shown in the Chi-squared values, spatial variation remained. Therefore, there are more factors that must be considered to fully explain relationships with tobacco outlet access and availability. However, a strength of this study is that the majority racial percentage and various SES measure did account for some spatial variation in all the study areas, exemplifying the importance of establishing a solid epidemiological foundation of determinants. As with other studies on place-

based disparities, the contextual interaction of race and socioeconomic status should not be disregarded but rather utilized as the basis for progressive tobacco outlet control and strict enforcement of existing tobacco control policies. Additionally, it should be an integral part of all health disparities research.

This study concludes that predominantly-White areas have lower tobacco outlet availability and access than predominantly-Black areas, despite both areas having similar socioeconomic status. It is suggested that socioeconomic status across racial composition, while seemingly comparable, should be contextualized with an acknowledgment of chronic inequalities created and perpetuated by systems of oppression such as racism, and that place-based disparities of tobacco outlet availability and access have a racial gradient and a socioeconomic gradient. Therefore, tobacco control policies should be attuned to racial differences in addition to socioeconomic differences in neighborhoods and communities.

Table 4.1: Descriptives of Sociodemographics and Tobacco Outlet Density of Prince George's County and Baltimore County, Maryland

Mean Characteristic Per Census Tract	Prince George's County (# Tracts = 218)	Baltimore County (# Tracts = 211)	*t-statistic*	*df*
Population (SD)	4,095.49 (1,546.78)	3,900.28 (1,638.74)	*1.27*	*427*
Black Population Percentage (SD)	64.88 (24.82)	24.92 (26.55)	***16.11***	*427*
White Population Percentage (SD)	19.93 (17.80)	66.21 (26.96)	***-21.05***	*427*
Median Household Income (SD)	$77,378 ($26,329)	$73,114 ($26,299)	*1.68*	*427*
Gini Coefficient (SD)	0.36 (0.05)	0.40 (0.05)	***-8.28***	*427*
Percentage of Individuals Aged 25+ with at Least a Bachelor's Degree (SD)	29.98 (14.57)	35.52 (19.86)	***-3.30***	*427*
Labor Force Participation Rate (SD)	72.65 (6.52)	66.34 (8.97)	***8.35***	*427*
Number of Vacant Houses	111.41 (85.62)	112.71 (95.46)	*0.15*	*427*
Tobacco Outlets per 1000 (SD)	0.56 (0.64)	0.35 (0.49)	***3.81***	*427*
Tobacco Outlet per 10km of Roadway (SD)	0.92 (1.22)	0.43 (0.53)	***5.36***	*427*

Table 4.2: Descriptives of Sociodemographics and Tobacco Outlet Density of Baltimore City and Western Maryland

Mean Characteristic Per Census Tract	Baltimore City (# Tracts = 199)	Western Maryland (# Tracts = 62)	*t-statistic*	*df*
Population (SD)	3,127.91 (1,387.09)	4,074.71 (1,808.71)	***-4.35***	*259*
Black Population Percentage (SD)	63.38 (34.14)	7.96 (11.78)	***12.54***	*259*
White Population Percentage (SD)	30.13 (30.58)	87.38 (13.78)	***-14.28***	*259*
Median Household Income (SD)	$44,264 ($23,899)	$48,164 ($18,290)	*-1.18*	*259*
Gini Coefficient (SD)	0.46 (0.06)	0.41 (0.07)	***5.50***	*259*
Percentage of Individuals Aged 25+ with at Least a Bachelor's Degree (SD)	27.36 (22.60)	18.40 (9.22)	***3.04***	*259*
Labor Force Participation Rate (SD)	62.26 (11.85)	59.57 (11.47)	*1.57*	*259*
Number of Vacant Houses	273.66 (172.24)	276.47 (555.03)	*0.06*	*259*
Tobacco Outlets per 1000 (SD)	2.57 (2.72)	0.22 (0.29)	***6.78***	*259*
Tobacco Outlets per 10km of Roadway (SD)	3.45 (3.36)	0.13 (0.21)	***7.77***	*259*

Table 4.3: Descriptives of Sociodemographics and Tobacco Outlet Density of Baltimore City and Lower Eastern Shore, Maryland

Mean Characteristic Per Census Tract	Baltimore City (# Tracts = 199)	Lower Eastern Shore (# Tracts = 50)	*t-statistic*	*df*
Population (SD)	3,127.91 (1,387.09)	4,244.30 (1,882.36)	***-4.71***	*247*
Black Population Percentage (SD)	63.38 (34.14)	23.12 (21.36)	***7.95***	*247*
White Population Percentage (SD)	30.13 (30.58)	71.70 (22.59)	***-9.01***	*247*
Median Household Income (SD)	$44,264 ($23,899)	$49,470 ($20,400)	*-1.42*	*247*
Gini Coefficient (SD)	0.46 (0.06)	0.44 (0.05)	***2.17***	*247*
Percentage of Individuals Aged 25+ with at Least a Bachelor's Degree (SD)	27.36 (22.60)	25.13 (11.18)	*0.68*	*247*
Labor Force Participation Rate (SD)	62.26 (11.85)	60.38 (11.29)	*1.01*	*247*
Number of Vacant Houses	273.66 (172.24)	917.82 (2,170.31)	***-4.16***	*247*
Tobacco Outlets per 1000 (SD)	2.57 (2.72)	0.64 (1.46)	***4.84***	*247*
Tobacco Outlets per 10km of Roadway(SD)	3.45 (3.36)	0.31 (0.64)	***6.57***	*247*

Table 4.4: Spatial Lag Regression Model Coefficients for Sociodemographics on Tobacco Outlet Availability in Prince George's County, Maryland – 2011-2015

Variable	Univariate Model		Multivariate Model			
			Focal Effects		Focal & Spatial Lag	
	Exponentiated Beta	p-value	Exponentiated Beta	p-value	Exponentiated Beta	p-value
Focal Effects						
Black Population Percentage (per 10%)	**1.00**	**<0.001**	**1.01**	**<0.001**	**0.95**	**<0.001**
Median Household Income (per $10000)	**0.96**	**<0.001**	**1.03**	**<0.001**	**1.08**	**<0.001**
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**0.85**	**<0.001**	**0.84**	**<0.001**	**0.99**	**<0.001**
Labor Force Participation Rate (per 10%)	**0.96**	**<0.001**	**1.06**	**<0.001**	**1.06**	**<0.001**
Gini Income Inequality Coefficient (per 1%)	**1.04**	**<0.001**	**1.05**	**<0.001**	**1.04**	**<0.001**
Vacant Houses (per 100)	**1.06**	**<0.001**	**0.99**	**<0.001**	**0.95**	**<0.001**
Spatial Lag						
Black Population Percentage (per 10%)	**1.02**	**<0.001**			**1.05**	**<0.001**
Median Household Income (per $10000)	**0.87**	**<0.001**			**0.97**	**<0.001**
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**0.78**	**<0.001**			**0.80**	**<0.001**
Labor Force Participation Rate (per 10%)	**0.96**	**<0.001**			0.92	0.17
Gini Income Inequality Coefficient (per 1%)	**1.07**	**<0.001**			**1.03**	**<0.001**
Vacant Houses (per 100)	**1.50**	**<0.001**			**1.28**	**<0.001**

Table 4.5: Spatial Lag Covariate Interaction Regression Model Coefficients for Sociodemographics on Tobacco Outlet Availability in Prince George's County, Maryland – 2011-2015

Variable	Multivariate Model			
	Focal & Spatial Lag		Focal & Spatial Lag Interaction	
	Exponentiated Beta	p-value	Exponentiated Beta	p-value
Focal Effects				
Black Population Percentage (per 10%)	**0.88**	**<0.001**	**1.00**	**<0.001**
Median Household Income (per $10000)	**0.92**	**<0.001**	**1.00**	**<0.001**
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**1.12**	**<0.001**	**1.00**	**<0.001**
Labor Force Participation Rate (per 10%)	**1.18**	**<0.01**	**1.06**	**<0.001**
Gini Income Inequality Coefficient (per 1%)	**1.49**	**<0.001**	**0.39**	**<0.001**
Vacant Houses (per 100)	**1.06**	**<0.001**	**1.00**	**<0.001**
Spatial Lag				
Black Population Percentage (per 10%)	**0.97**	**<0.001**		
Median Household Income (per $10000)	**0.82**	**<0.001**		
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**0.87**	**<0.001**		
Labor Force Participation Rate (per 10%)	**1.27**	**<0.001**		
Gini Income Inequality Coefficient (per 1%)	**1.48**	**<0.001**		
Vacant Houses (per 100)	**1.30**	**<0.001**		

Table 4.6: Spatial Lag Regression Model Coefficients for Sociodemographics on Tobacco Outlet Access in Prince George's County, Maryland – 2011-2015

Variable	Univariate Model		Multivariate Model			
			Focal Effects		Focal & Spatial Lag	
	Exponentiated Beta	p-value	Exponentiated Beta	p-value	Exponentiated Beta	p-value
Focal Effects						
Black Population Percentage (per 10%)	**1.00**	**<0.001**	**1.00**	**<0.001**	**1.06**	**<0.001**
Median Household Income (per $10000)	**0.90**	**<0.001**	**0.97**	**<0.001**	**1.05**	**<0.001**
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**0.73**	**<0.001**	**0.78**	**<0.001**	**0.93**	**<0.001**
Labor Force Participation Rate (per 10%)	**1.14**	**<0.001**	**1.37**	**<0.001**	**1.14**	**<0.001**
Gini Income Inequality Coefficient (per 1%)	**1.06**	**<0.001**	**1.07**	**<0.001**	**1.04**	**<0.001**
Vacant Houses (per 100)	**1.16**	**<0.001**	**0.99**	**<0.001**	**0.98**	**<0.001**
Spatial Lag						
Black Population Percentage (per 10%)	**0.97**	**<0.001**			**0.95**	**<0.001**
Median Household Income (per $10000)	**0.75**	**<0.001**			**0.88**	**<0.001**
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**0.64**	**<0.001**			**0.82**	**<0.001**
Labor Force Participation Rate (per 10%)	**1.74**	**<0.001**			**1.58**	**<0.001**
Gini Income Inequality Coefficient (per 1%)	**1.14**	**<0.001**			**1.07**	**<0.001**
Vacant Houses (per 100)	**1.58**	**<0.001**			**1.00**	**<0.001**

Table 4.7: Spatial Lag Covariate Interaction Regression Model Coefficients for Sociodemographics on Tobacco Outlet Access in Prince George's County, Maryland – 2011-2015

Variable	Multivariate Model			
	Focal & Spatial Lag		Focal & Spatial Lag Interaction	
	Exponentiated Beta	p-value	Exponentiated Beta	p-value
Focal Effects				
Black Population Percentage (per 10%)	**0.94**	**<0.001**	**1.00**	**<0.001**
Median Household Income (per $10000)	**0.81**	**<0.001**	**1.00**	**<0.001**
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**0.97**	**<0.001**	**1.00**	**<0.001**
Labor Force Participation Rate (per 10%)	**0.02**	**<0.001**	**1.06**	**<0.001**
Gini Income Inequality Coefficient (per 1%)	**1.16**	**<0.001**	**0.75**	**<0.001**
Vacant Houses (per 100)	**0.99**	**<0.001**	1.00	0.49
Spatial Lag				
Black Population Percentage (per 10%)	**0.86**	**<0.001**		
Median Household Income (per $10000)	**0.66**	**<0.001**		
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**0.89**	**<0.001**		
Labor Force Participation Rate (per 10%)	**0.41**	**<0.001**		
Gini Income Inequality Coefficient (per 1%)	**1.18**	**<0.001**		
Vacant Houses (per 100)	1.00	0.37		

Table 4.8: Spatial Lag Regression Model Coefficients for Sociodemographics on Tobacco Outlet Availability in Baltimore City, Maryland – 2011-2015

Variable	Univariate Model		Multivariate Model			
			Focal Effects		Focal & Spatial Lag	
	Exponentiated Beta	p-value	Exponentiated Beta	p-value	Exponentiated Beta	p-value
Focal Effects						
Black Population Percentage (per 10%)	1.00	0.88	**0.92**	**<0.001**	**0.95**	**<0.001**
Median Household Income (per $10000)	**0.96**	**<0.001**	**1.01**	**<0.001**	**1.01**	**<0.001**
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**0.95**	**<0.001**	**0.89**	**<0.001**	**0.90**	**<0.001**
Labor Force Participation Rate (per 10%)	**0.98**	**<0.001**	**1.10**	**<0.001**	**1.12**	**<0.001**
Gini Income Inequality Coefficient (per 1%)	**1.03**	**<0.001**	**1.03**	**<0.001**	**1.03**	**<0.001**
Vacant Houses (per 100)	**1.22**	**<0.001**	**1.23**	**<0.001**	**1.17**	**<0.001**
Spatial Lag						
Black Population Percentage (per 10%)	**1.00**	**<0.001**			**0.94**	**<0.001**
Median Household Income (per $10000)	**0.89**	**<0.001**			**1.02**	**<0.001**
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**0.91**	**<0.001**			**0.97**	**<0.001**
Labor Force Participation Rate (per 10%)	**0.82**	**<0.001**			**1.04**	**<0.001**
Gini Income Inequality Coefficient (per 1%)	**1.07**	**<0.001**			**1.04**	**<0.001**
Vacant Houses (per 100)	**1.29**	**<0.001**			**1.12**	**<0.001**

Table 4.9: Spatial Lag Covariate Interaction Regression Model Coefficients for Sociodemographics on Tobacco Outlet Availability in Baltimore City, Maryland – 2011-2015

Variable	Multivariate Model			
	Focal & Spatial Lag		Focal & Spatial Lag Interaction	
	Exponentiated Beta	p-value	Exponentiated Beta	p-value
Focal Effects				
Black Population Percentage (per 10%)	**0.96**	**<0.001**	**1.00**	**<0.001**
Median Household Income (per $10000)	**1.13**	**<0.001**	**1.00**	**<0.001**
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**0.88**	**<0.001**	**1.00**	**<0.001**
Labor Force Participation Rate (per 10%)	**0.65**	**<0.001**	**1.01**	**<0.001**
Gini Income Inequality Coefficient (per 1%)	**0.96**	**<0.001**	**1.17**	**<0.001**
Vacant Houses (per 100)	**1.42**	**<0.001**	**1.00**	**<0.001**
Spatial Lag				
Black Population Percentage (per 10%)	**0.95**	**<0.001**		
Median Household Income (per $10000)	**1.15**	**<0.001**		
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**0.93**	**<0.001**		
Labor Force Participation Rate (per 10%)	**0.57**	**<0.001**		
Gini Income Inequality Coefficient (per 1%)	**0.97**	**<0.001**		
Vacant Houses (per 100)	**1.31**	**<0.001**		

Table 4.10: Spatial Lag Regression Model Coefficients for Sociodemographics on Tobacco Outlet Access in Baltimore City, Maryland – 2011-2015

Variable	Univariate Model		Multivariate Model			
			Focal Effects		Focal & Spatial Lag	
	Exponentiated Beta	p-value	Exponentiated Beta	p-value	Exponentiated Beta	p-value
Focal Effects						
Black Population Percentage (per 10%)	**1.01**	**<0.001**	**0.95**	**<0.001**	**1.00**	**<0.001**
Median Household Income (per $10000)	**0.96**	**<0.001**	**0.99**	**<0.001**	**1.00**	**<0.001**
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**0.96**	**<0.001**	**0.95**	**<0.001**	**0.97**	**<0.001**
Labor Force Participation Rate (per 10%)	**0.94**	**<0.001**	**1.13**	**<0.001**	**1.16**	**<0.001**
Gini Income Inequality Coefficient (per 1%)	**1.04**	**<0.001**	**1.04**	**<0.001**	**1.04**	**<0.001**
Vacant Houses (per 100)	**1.21**	**<0.001**	**1.23**	**<0.001**	**1.18**	**<0.001**
Spatial Lag						
Black Population Percentage (per 10%)	**1.01**	**<0.001**			**0.93**	**<0.001**
Median Household Income (per $10000)	**0.91**	**<0.001**			**0.97**	**<0.001**
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**0.94**	**<0.001**			**0.96**	**<0.001**
Labor Force Participation Rate (per 10%)	**0.85**	**<0.001**			**1.11**	**<0.001**
Gini Income Inequality Coefficient (per 1%)	**1.07**	**<0.001**			**1.05**	**<0.001**
Vacant Houses (per 100)	**1.27**	**<0.001**			**1.09**	**<0.001**

Table 4.11: Spatial Lag Covariate Interaction Regression Model Coefficients for Sociodemographics on Tobacco Outlet Access in Baltimore City, Maryland – 2011-2015

Variable	Multivariate Model			
	Focal & Spatial Lag		Focal & Spatial Lag Interaction	
	Exponentiated Beta	p-value	Exponentiated Beta	p-value
Focal Effects				
Black Population Percentage (per 10%)	**1.05**	**<0.001**	**1.00**	**<0.001**
Median Household Income (per $10000)	**1.06**	**<0.001**	**1.00**	**<0.001**
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**0.92**	**<0.001**	**1.00**	**<0.001**
Labor Force Participation Rate (per 10%)	**0.45**	**<0.001**	**1.01**	**<0.001**
Gini Income Inequality Coefficient (per 1%)	**0.92**	**<0.001**	**1.30**	**<0.001**
Vacant Houses (per 100)	**1.38**	**<0.001**	**1.00**	**<0.001**
Spatial Lag				
Black Population Percentage (per 10%)	**0.99**	**<0.001**		
Median Household Income (per $10000)	**1.03**	**<0.001**		
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**0.94**	**<0.001**		
Labor Force Participation Rate (per 10%)	**0.40**	**<0.001**		
Gini Income Inequality Coefficient (per 1%)	**0.92**	**<0.001**		
Vacant Houses (per 100)	**1.26**	**<0.001**		

Table 4.12: Spatial Lag Regression Model Coefficients for Sociodemographics on Tobacco Outlet Access in Western Maryland – 2011-2015

Variable	Univariate Model		Multivariate Model			
			Focal Effects		Focal & Spatial Lag	
	Exponentiated Beta	p-value	Exponentiated Beta	p-value	Exponentiated Beta	p-value
Focal Effects						
White Population Percentage (per 10%)	**0.72**	**<0.001**	**0.84**	**<0.001**	**1.16**	**<0.001**
Median Household Income (per $10000)	**0.84**	**<0.001**	**0.86**	**<0.001**	**0.89**	**<0.001**
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**1.04**	**<0.001**	**1.13**	**<0.001**	**1.08**	**<0.01**
Labor Force Participation Rate (per 10%)	**0.89**	**<0.001**	**0.98**	**<0.001**	**0.83**	**<0.001**
Gini Income Inequality Coefficient (per 1%)	**1.04**	**<0.001**	**1.07**	**<0.001**	**1.07**	**<0.001**
Vacant Houses (per 100)	**0.88**	**<0.001**	**0.87**	**<0.001**	**0.92**	**<0.001**
Spatial Lag						
White Population Percentage (per 10%)	**0.69**	**<0.001**			**0.72**	**<0.001**
Median Household Income (per $10000)	**0.90**	**<0.001**			**1.07**	**<0.001**
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	1.00	0.99			**0.84**	**<0.001**
Labor Force Participation Rate (per 10%)	**1.10**	**<0.001**			**1.65**	**<0.001**
Gini Income Inequality Coefficient (per 1%)	**1.03**	**<0.001**			**1.14**	**<0.001**
Vacant Houses (per 100)	**0.91**	**<0.001**			**0.91**	**<0.001**

Table 4.13: Spatial Lag Covariate Interaction Regression Model Coefficients for Sociodemographics on Tobacco Outlet Access in Western Maryland – 2011-2015

Variable	Multivariate Model			
	Focal & Spatial Lag		Focal & Spatial Lag Interaction	
	Exponentiated Beta	p-value	Exponentiated Beta	p-value
Focal Effects				
White Population Percentage (per 10%)	**3.94**	**<0.001**	**0.99**	**<0.001**
Median Household Income (per $10000)	**0.63**	**<0.001**	**1.00**	**<0.001**
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**0.14**	**<0.001**	**1.11**	**<0.001**
Labor Force Participation Rate (per 10%)	**18379.66**	**<0.001**	**0.85**	**<0.001**
Gini Income Inequality Coefficient (per 1%)	**2.62**	**<0.001**	**0.12**	**<0.001**
Vacant Houses (per 100)	**0.90**	**<0.001**	**1.00**	**<0.001**
Spatial Lag				
White Population Percentage (per 10%)	**2.70**	**<0.001**		
Median Household Income (per $10000)	**0.80**	**<0.001**		
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**0.09**	**<0.001**		
Labor Force Participation Rate (per 10%)	**24343.01**	**<0.001**		
Gini Income Inequality Coefficient (per 1%)	**2.76**	**<0.001**		
Vacant Houses (per 100)	**0.89**	**<0.001**		

Table 4.14: Spatial Lag Regression Model Coefficients for Sociodemographics on Tobacco Outlet Access in Lower Eastern Shore, Maryland – 2011-2015

Variable	Univariate Model		Multivariate Model			
			Focal Effects		Focal & Spatial Lag	
	Exponentiated Beta	p-value	Exponentiated Beta	p-value	Exponentiated Beta	p-value
Focal Effects						
White Population Percentage (per 10%)	**1.03**	**<0.001**	**0.80**	**<0.001**	**0.77**	**<0.001**
Median Household Income (per $10000)	**1.02**	**<0.001**	**1.08**	**<0.001**	**1.13**	**<0.001**
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**1.63**	**<0.001**	**1.39**	**<0.001**	**1.25**	**<0.001**
Labor Force Participation Rate (per 10%)	**0.83**	**<0.001**	**1.19**	**<0.001**	**1.03**	**<0.001**
Gini Income Inequality Coefficient (per 1%)	**1.13**	**<0.001**	**1.16**	**<0.001**	**1.16**	**<0.001**
Vacant Houses (per 100)	**1.03**	**<0.001**	**1.03**	**<0.001**	**1.01**	**<0.001**
Spatial Lag						
White Population Percentage (per 10%)	**1.38**	**<0.001**			**0.89**	**<0.001**
Median Household Income (per $10000)	**1.27**	**<0.001**			**1.24**	**<0.001**
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**2.75**	**<0.001**			**1.39**	**<0.001**
Labor Force Participation Rate (per 10%)	**1.01**	**<0.001**			**1.26**	**<0.001**
Gini Income Inequality Coefficient (per 1%)	**1.08**	**<0.001**			**1.11**	**<0.001**
Vacant Houses (per 100)	**1.05**	**<0.001**			**1.02**	**<0.001**

Table 4.15: Spatial Lag Covariate Interaction Regression Model Coefficients for Sociodemographics on Tobacco Outlet Access in Lower Eastern Shore, Maryland – 2011-2015

Variable	Multivariate Model			
	Focal & Spatial Lag		Focal & Spatial Lag Interaction	
	Exponentiated Beta	p-value	Exponentiated Beta	p-value
Focal Effects				
White Population Percentage (per 10%)	**1.03**	**<0.01**	**0.99**	**<0.001**
Median Household Income (per $10000)	**0.19**	**<0.001**	**1.00**	**<0.001**
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**0.75**	**<0.001**	**1.02**	**<0.001**
Labor Force Participation Rate (per 10%)	**5.50**	**<0.001**	**1.03**	**<0.001**
Gini Income Inequality Coefficient (per 1%)	**0.14**	**<0.001**	**125.59**	**<0.001**
Vacant Houses (per 100)	**0.99**	**<0.01**	**1.00**	**<0.001**
Spatial Lag				
White Population Percentage (per 10%)	1.21	<0.001		
Median Household Income (per $10000)	**0.27**	**<0.001**		
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	0.73	<0.001		
Labor Force Participation Rate (per 10%)	**7.05**	**<0.001**		
Gini Income Inequality Coefficient (per 1%)	**0.14**	**<0.001**		
Vacant Houses (per 100)	**0.98**	**<0.001**		

Table 4.16: Spatial Lag Regression Model Coefficients for Sociodemographics on Tobacco Outlet Access in Baltimore County, Maryland – 2011-2015

Variable	Univariate Model		Multivariate Model			
			Focal Effects		Focal & Spatial Lag	
	Exponentiated Beta	p-value	Exponentiated Beta	p-value	Exponentiated Beta	p-value
Focal Effects						
White Population Percentage (per 10%)	**0.91**	**<0.001**	**0.96**	**<0.001**	**1.03**	**<0.001**
Median Household Income (per $10000)	**0.82**	**<0.001**	**0.88**	**0.01**	**0.90**	**<0.001**
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**0.77**	**<0.001**	**0.83**	**<0.001**	**0.90**	**<0.001**
Labor Force Participation Rate (per 10%)	1.00	0.36	**1.13**	**<0.001**	**1.14**	**<0.001**
Gini Income Inequality Coefficient (per 1%)	**1.00**	**<0.001**	**1.04**	**<0.001**	**1.05**	**<0.001**
Vacant Houses (per 100)	**1.02**	**<0.001**	**0.86**	**<0.001**	**0.86**	**<0.001**
Spatial Lag						
White Population Percentage (per 10%)	**0.89**	**<0.001**			**0.95**	**<0.001**
Median Household Income (per $10000)	**0.70**	**<0.001**			**0.68**	**<0.001**
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**0.75**	**<0.001**			**1.34**	**<0.001**
Labor Force Participation Rate (per 10%)	**0.78**	**<0.001**			**0.61**	**<0.001**
Gini Income Inequality Coefficient (per 1%)	**0.93**	**<0.001**			**0.95**	**<0.001**
Vacant Houses (per 100)	**1.98**	**<0.001**			**1.15**	**<0.001**

Table 4.17: Spatial Lag Covariate Interaction Regression Model Coefficients for Sociodemographics on Tobacco Outlet Access in Baltimore County, Maryland – 2011-2015

Variable	Multivariate Model			
	Focal & Spatial Lag		Focal & Spatial Lag Interaction	
	Exponentiated Beta	p-value	Exponentiated Beta	p-value
Focal Effects				
White Population Percentage (per 10%)	**0.95**	**<0.001**	**1.00**	**<0.001**
Median Household Income (per $10000)	**0.99**	**<0.001**	**1.00**	**<0.001**
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**0.99**	**<0.001**	**1.00**	**<0.001**
Labor Force Participation Rate (per 10%)	**63.18**	**<0.001**	**0.94**	**<0.001**
Gini Income Inequality Coefficient (per 1%)	**0.65**	**<0.001**	**3.14**	**<0.001**
Vacant Houses (per 100)	**0.91**	**<0.001**	**1.00**	**<0.001**
Spatial Lag				
White Population Percentage (per 10%)	**0.96**	**<0.001**		
Median Household Income (per $10000)	**0.74**	**<0.001**		
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**1.22**	**<0.001**		
Labor Force Participation Rate (per 10%)	**50.35**	**<0.001**		
Gini Income Inequality Coefficient (per 1%)	**0.60**	**<0.001**		
Vacant Houses (per 100)	**1.22**	**<0.001**		

Table 4.18: Spatial Lag Covariate Interaction Regression Model Coefficients for Sociodemographics on Tobacco Outlet Availability in Prince George's County, Maryland Compared to Baltimore County, Maryland – 2011-2015

Variable	Multivariate Model			
	Focal & Spatial Lag		Focal & Spatial Lag Interaction	
	Exponentiated Beta	p-value	Exponentiated Beta	p-value
Focal Effects				
Median Household Income (per $10000)	**1.07**	**<0.001**	**1.00**	**0.01**
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**1.03**	**<0.001**	**1.00**	**<0.001**
Labor Force Participation Rate (per 10%)	**2.16**	**<0.001**	**0.99**	**<0.001**
Gini Income Inequality Coefficient (per 1%)	**1.07**	**<0.001**	**0.94**	**<0.001**
Vacant Houses (per 100)	**0.88**	**<0.001**	**1.00**	**<0.001**
Spatial Lag				
Median Household Income (per $10000)	**0.92**	**<0.001**		
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**0.94**	**<0.001**		
Labor Force Participation Rate (per 10%)	**1.74**	**<0.001**		
Gini Income Inequality Coefficient (per 1%)	**1.03**	**<0.001**		
Vacant Houses (per 100)	**1.22**	**<0.001**		
County	**2.00**	**<0.001**		

Table 4.19: Spatial Lag Covariate Interaction Regression Model Coefficients for Sociodemographics on Tobacco Outlet Access in Prince George's County, Maryland Compared to Baltimore County, Maryland – 2011-2015

Variable	Multivariate Model			
	Focal & Spatial Lag		Focal & Spatial Lag Interaction	
	Exponentiated Beta	p-value	Exponentiated Beta	p-value
Focal Effects				
Median Household Income (per $10000)	**0.95**	**<0.001**	**1.00**	**0.01**
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**0.95**	**<0.001**	**1.00**	**<0.001**
Labor Force Participation Rate (per 10%)	**0.83**	**<0.001**	**1.00**	**<0.001**
Gini Income Inequality Coefficient (per 1%)	**0.86**	**<0.001**	**1.66**	**<0.001**
Vacant Houses (per 100)	**0.93**	**<0.001**	**1.00**	**<0.001**
Spatial Lag				
Median Household Income (per $10000)	**0.73**	**<0.001**		
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	1.00	0.35		
Labor Force Participation Rate (per 10%)	**0.76**	**<0.001**		
Gini Income Inequality Coefficient (per 1%)	**0.82**	**<0.001**		
Vacant Houses (per 100)	**1.00**	**0.001**		
County	**2.12**	**<0.001**		

Table 4.20: Spatial Lag Covariate Interaction Regression Model Coefficients for Sociodemographics on Tobacco Outlet Availability in Western Maryland Compared to Baltimore City, Maryland – 2011-2015

Variable	Multivariate Model			
	Focal & Spatial Lag		Focal & Spatial Lag Interaction	
	Exponentiated Beta	p-value	Exponentiated Beta	p-value
Focal Effects				
Median Household Income (per $10000)	**1.15**	**<0.001**	**1.00**	**<0.001**
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**0.85**	**<0.001**	**1.00**	**<0.001**
Labor Force Participation Rate (per 10%)	**0.98**	**0.02**	**1.00**	**<0.001**
Gini Income Inequality Coefficient (per 1%)	**0.95**	**<0.001**	**1.20**	**<0.001**
Vacant Houses (per 100)	**1.35**	**<0.001**	**1.00**	**<0.001**
Spatial Lag				
Median Household Income (per $10000)	**1.18**	**<0.001**		
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**0.91**	**<0.001**		
Labor Force Participation Rate (per 10%)	0.99	0.33		
Gini Income Inequality Coefficient (per 1%)	**0.97**	**<0.001**		
Vacant Houses (per 100)	**1.33**	**<0.001**		

Table 4.21: Spatial Lag Covariate Interaction Regression Model Coefficients for Sociodemographics on Tobacco Outlet Access in Western Maryland Compared to Baltimore City, Maryland – 2011-2015

Variable	Multivariate Model			
	Focal & Spatial Lag		Focal & Spatial Lag Interaction	
	Exponentiated Beta	p-value	Exponentiated Beta	p-value
Focal Effects				
Median Household Income (per $10000)	**1.06**	**<0.001**	**1.00**	**<0.001**
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**0.90**	**<0.001**	**1.00**	**<0.001**
Labor Force Participation Rate (per 10%)	**0.83**	**0.02**	**1.00**	**<0.001**
Gini Income Inequality Coefficient (per 1%)	**0.93**	**<0.001**	**1.26**	**<0.001**
Vacant Houses (per 100)	**1.29**	**<0.001**	**1.00**	**<0.001**
Spatial Lag				
Median Household Income (per $10000)	**1.05**	**<0.001**		
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**0.96**	**<0.001**		
Labor Force Participation Rate (per 10%)	**0.89**	**<0.001**		
Gini Income Inequality Coefficient (per 1%)	**0.95**	**<0.001**		
Vacant Houses (per 100)	**1.28**	**<0.001**		

Table 4.22: Spatial Lag Covariate Interaction Regression Model Coefficients for Sociodemographics on Tobacco Outlet Availability in Lower Eastern Shore, Maryland Compared to Baltimore City, Maryland – 2011-2015

Variable	Multivariate Model			
	Focal & Spatial Lag		Focal & Spatial Lag Interaction	
	Exponentiated Beta	p-value	Exponentiated Beta	p-value
Focal Effects				
Median Household Income (per $10000)	**1.14**	**<0.001**	**1.00**	**<0.001**
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**0.84**	**<0.001**	**1.00**	**<0.001**
Labor Force Participation Rate (per 10%)	**0.93**	**<0.001**	**1.00**	**<0.001**
Gini Income Inequality Coefficient (per 1%)	**0.96**	**<0.001**	**1.19**	**<0.001**
Vacant Houses (per 100)	**1.06**	**<0.001**	**1.00**	**<0.001**
Spatial Lag				
Median Household Income (per $10000)	**1.14**	**<0.001**		
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**0.87**	**<0.001**		
Labor Force Participation Rate (per 10%)	**0.93**	**<0.001**		
Gini Income Inequality Coefficient (per 1%)	**0.53**	**0.002**		
Vacant Houses (per 100)	**1.05**	**<0.001**		

Table 4.23: Spatial Lag Covariate Interaction Regression Model Coefficients for Sociodemographics on Tobacco Outlet Access in Western Maryland Compared to Baltimore City, Maryland – 2011-2015

Variable	Multivariate Model			
	Focal & Spatial Lag		Focal & Spatial Lag Interaction	
	Exponentiated Beta	p-value	Exponentiated Beta	p-value
Focal Effects				
Median Household Income (per $10000)	**1.06**	**<0.001**	**1.00**	**<0.001**
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**0.90**	**<0.001**	**1.00**	**<0.001**
Labor Force Participation Rate (per 10%)	**0.63**	**<0.001**	**1.01**	**<0.001**
Gini Income Inequality Coefficient (per 1%)	**0.94**	**<0.001**	**1.26**	**<0.001**
Vacant Houses (per 100)	**1.07**	**<0.001**	**1.00**	**<0.001**
Spatial Lag				
Median Household Income (per $10000)	**1.04**	**<0.001**		
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**0.94**	**<0.001**		
Labor Force Participation Rate (per 10%)	**0.66**	**<0.001**		
Gini Income Inequality Coefficient (per 1%)	**0.97**	**0.002**		
Vacant Houses (per 100)	**1.05**	**<0.001**		

Chapter 5: The relationships between sociodemographics, tobacco outlet availability and tobacco outlet access in Maryland: A statewide descriptive epidemiological analysis

Abstract

Introduction: There have been a limited number of statewide and nationwide studies that examined the relationships between sociodemographics and tobacco outlet density. While the studies provided valuable insight into the extent to which sociodemographic factors are associated with tobacco outlet density in large areas, the studies shared three common limitations: utilization of older sociodemographic data, utilization of older tobacco outlet data and utilization of one measure of tobacco outlet density. This study aimed to advance the research conducted in the statewide and nationwide tobacco outlet density studies by addressing the three previously mentioned limitations in a descriptive epidemiological statewide analysis of Maryland, a racially heterogeneous locale. Methods: This study utilized tobacco outlet license data from the Maryland State Licensing Bureau, geocoded the addresses via the State of Maryland's Mapping and GIS Data Portal, and combined the addresses with 2011-2015 American Community Survey demographic data. Tobacco outlet availability was measured as the number of tobacco outlets per 1,000 persons per Census Tract, and tobacco outlet access was measured as the number of tobacco outlets per 10km of roadway. Descriptive statistics were run for the state of Maryland, and spatial lag Poisson models were conducted to examine sociodemographics' relationships with tobacco outlet availability and access, including race and socioeconomic status-exclusive models. Results: Maryland had a tobacco outlet availability of 0.64 outlets per 1,000 persons per Census Tract, and a tobacco outlet access of 0.86 outlets per 10km of roadway. Spatial lag model results showed consistent direct relationships between Black population percentage, income inequality, vacant houses, labor force participation rate and

tobacco outlet density and access, and consistent inverse relationships between median household income, White population percentage, education and tobacco outlet availability and access. However, some differences in relationships were found based on the outcome measure, proximal Census Tracts vs. distal Census Tract neighborhoods, or both. Discussion: Study results validate findings from previous statewide and nationwide studies, in that Blacks and individuals with lower socioeconomic status are associated with greater tobacco outlet availability and greater tobacco outlet access. Additionally, the study results illustrate the importance of considering both tobacco outlet availability and tobacco outlet access, and the relationships with both outcomes in immediate and extended study areas.

Introduction

Few research studies that have examined the relationships between sociodemographics and tobacco outlet density utilized study areas larger than cities and/or counties. Currently only five studies utilized statewide data, and those studies involved three states – Iowa, New Jersey and New York (Reid et. al, 2005; Peterson et. al, 2005; Peterson et. al, 2011; Reid et. al, 2013; Loomis et. al, 2013), and only two studies have been conducted that utilized nationwide data (Rodriguez et. al, 2012; Lee et. al, 2017). Each study has contributed to the understanding of how sociodemographics are associated with tobacco outlet density, particularly non-White populations and median household income. However, the studies share some common limitations. One limitation is the utilization of older sociodemographic data. Four out of the five statewide studies utilized sociodemographic data from the 2000 Decennial Census, while Loomis and colleagues (2013) utilized 2009 New York state sociodemographic data. Among nationwide studies, Rodriguez and colleagues also utilized sociodemographic data from the 2000 Decennial Census. Another limitation is the utilization of older tobacco outlet data. Reid and colleagues

(2013) utilized 2004 tobacco outlet data in their statewide analysis of New Jersey, while Loomis and colleagues (2013) utilized 2009 tobacco outlet data in their statewide analysis of New York. Both Reid and colleagues (2005) and Peterson and colleagues (2005) utilized end-2002 tobacco outlet data for their statewide analyses of Iowa. The gap in data did not allow for consideration of recent changes in tobacco outlet density, such as CVS' decision to discontinue tobacco sales in their pharmacies nationwide (Polinski et. al, 2017). The last limitation is the utilization of one tobacco outlet density measure. All five statewide studies operationalized tobacco outlet density as the number of tobacco outlets per 10km of roadway, a measure indicative of access to tobacco outlets. Conversely, both nationwide studies operationalized tobacco outlet density as the number of tobacco outlets per 1,000 persons, a measure indicative of availability of tobacco outlets.

This study aimed to advance the research conducted in the statewide and nationwide tobacco outlet density studies by addressing the three previously mentioned limitations in a descriptive epidemiological statewide analysis of Maryland. To address the first limitation, sociodemographic data from the 2011-2015 American Community Survey were utilized. To address the second limitation, Maryland tobacco outlet license data from May 1, 2016 through April 30, 2017 were utilized. Finally, to address the third limitation analyses were conducted utilizing both a measure of tobacco outlet availability – the number of tobacco outlets per 1,000 persons per Census Tract – and a measure of tobacco outlet access – the number of tobacco outlets per 10km of roadway. Additionally, as mentioned in previous aims, Maryland has a rich ecological-contextual sociodemographic heterogeneity which presented a unique opportunity to examine the relationships between race, socioeconomic status and tobacco outlet density. Consistent with Aims I and II, the descriptive epidemiological statewide study included multiple

measures of socioeconomic status to allow for more insight into the relationship with tobacco outlet density beyond just median household income.

Methods

Census Tract demographic data were obtained from the 2011-2015 American Community Survey (ACS), made available via the United States Census website. The American Community Survey, inaugurated in 2005, is a perennial survey administered by the U.S. Census Bureau that acquires data on the sociodemographic dynamics of people living in the United States (U.S. Census Bureau, 2016). The five-year pooled estimate of sociodemographic data was preferred over the one-year and three-year pooled estimates because of the larger dataset that included data for all areas, thus allowing for examination of small Residential Census Tracts, and greater reliability. Of the 1,406 Census Tracts in Maryland, 18 had a total population of less than 600 persons and consistent with the methodology from Fakunle et. al (2016) were excluded from analyses. The exclusion resulted in a final total of 1,388 included in the analyses. Maryland tobacco outlet data – including retailer names, contact information and retail/mailing locations – were obtained from the Maryland State Licensing Bureau, which provided the addresses for retailers with an active Cigarette, Special Cigarette, Other Tobacco Product (OTP) or Tobacconist licenses as of April 30, 2017. The sale of loose cigarettes in prohibited by Maryland state law, although licensed retailers may engage in the activity (Smith et. al, 2007). Tobacco outlet retail addresses were geocoded via MD iMap – the State of Maryland's Mapping and GIS Data Portal – the most current publicly available geocoding service for the state. Of the addresses provided (n = 2,851), only five needed to be modified: one determined to be a duplicate (deleted), one determined to be out-of-state (Florida) with no alternative address given (deleted), one determined to have two adjacent addresses (second address added), one determined to be closed (deleted), and one geocoded with the mailing address due to the outlet being a food truck.

Most of the licensed tobacco outlets were successfully geocoded after the first iteration. Of the revised total addresses (n = 2,849), all but 144 were successfully geocoded via the Batch Address Look-Up service. The 144 entries that did not return a geocode were cross-referenced with Google Maps and other internet-based resources (e.g., retailer websites) to verify the correct address. After verification, the addresses were re-run via the Single Address Look-Up service of which all but 19 were successfully geocoded. In total, 2,830 of the 2,849 addresses (99.3%) were successfully geocoded. The addresses were then merged with Maryland sociodemographic data via the Spatial Join tool in ArcGIS. It was then determined that a total of 3 tobacco outlets were located among the 18 Census Tracts excluded from analyses. Eight variables measuring racial composition, socioeconomic status and built environment were selected from the ACS dataset. The expansion of socioeconomic covariates beyond the study of two predominantly-Black locales in Maryland by Fakunle and colleagues (2016) was to provide a more thorough understanding of the relationship between socioeconomic status, race and tobacco outlet density beyond one measure – median household income (Mayers et. al, 2012; Rodriguez et. al, 2012; Lee et. al, 2017). Additionally, the expansion of socioeconomic covariates aimed to address the lack of consideration in research for income inequality's influence in health disparities (Kawachi & Kennedy, 1999; Subramanian & Kawachi, 2004; Fakunle et. al, 2010). The measures included in the study were the total population, the total number of individuals who identify as Black or African American (converted to a percentage), the total number of individuals who identify as White (converted to a percentage), the percentage of individuals 25 years and over who have obtained at least a Bachelor's degree, the Gini index of income inequality (presented as a coefficient), the total number of vacant housing units, the total number of individuals 16 years and older who are actively in the labor force (converted to a percentage), and median household

income, expressed in 2015 inflation-adjusted dollars. Residential Census Tracts have been the prevailing spatial unit of measurement in tobacco outlet density research, yet other spatial units have been utilized in tobacco outlet density studies such as census block groups, which are smaller and more refined than Residential Census Tracts (Reid et. al, 2005; Ogneva-Himmelberger et. al, 2010). Similar research in alcohol outlet density have also used census block groups as the spatial unit of measurement (Gorman et. al, 2001; Morrison et. al, 2016; Grubesic et. al, 2016). While there is no consensus unit of measurement, Residential Census Tracts are the most frequently used. Census block groups, while more refined than Residential Census Tracts, have more variation which can lead to analytical instability. Likewise, analyses of broad jurisdictions like cities, counties or states may lead to results that do not allow for inference (Yu et. al, 2010). Therefore, Residential Census Tracts are currently the best spatial units that both exude distinct neighborhood characteristics yet provide manageable data and potentially generalizable analysis results.

Statistical Analyses

Spatial lag Poisson models were conducted to show the individual and collective effects of the sociodemographic covariates on tobacco outlet density within the state of Maryland. The covariates were spatially lagged, meaning that the models included coefficients for the covariate in the immediate, proximal Census Tracts (focal effects) and the extended, distal environment around Census Tracts (spatial lag effects). To conduct spatial analyses of social factors and tobacco outlet density, neighborhood structures were created. In spatial statistics, a neighborhood structure is an arrangement of spatial data and in this study, an arrangement of tobacco outlet and sociodemographic data (Fischer & Gettis, 2013). For this analysis and to best adjust for spatial dependence, a "neighborhood" was defined as a Census Tract that shared at least more than one

boundary with another Census Tract. Weight matrices – quantified representations of spatial relationships – were then created based on the neighborhood structures. The Census Tracts and sociodemographics data for each Tract provided the features needed to create the matrices. After the creation of the weight matrices, spatial smoothing was conducted to assure more consistent outcomes tobacco outlet density measures across the established Census Tracts. Spatial smoothing is a technique that aggregated the sociodemographic and tobacco outlet data across polygons (Census Tracts) to create more robust estimates and improve accuracy (Auchincloss et. al, 2012). The spatial smoothing was based on population, so areas with a higher population were weighted more heavily than area with a lower population. After spatial smoothing, Moran's I was tested to determine whether jurisdictions exhibited spatial dependence. Moran's I is a correlation coefficient, ranging from -1 to 1, that measures the extent of spatial dependence. A coefficient closer to 1 indicates similarity between adjacent areas, a coefficient closer to -1 indicates dissimilarity between adjacent areas, and a coefficient closer to zero indicates no correlation between adjacent areas (Statistics How To, 2017). All spatial analyses were conducted via the RStudio software package. Four models were conducted for each study area: a univariate model for each covariate, a multivariate model for focal effect covariates, a multivariate model for focal effect and spatially lagged covariates, and a multivariate model for focal effect and spatially lagged covariates, and interaction terms between the focal effect and spatially lagged covariates. Exponentiated beta coefficients were reported and magnified for easier interpretation. Due to the high number of significant coefficients in the models, the results section highlights focal effect and/or spatially lagged covariates that exhibited a consistent relationship (direct or inverse) across all four models. Chi-square statistics were conducted to determine the extent of overdispersion, or presence of greater variability, in the final model

compared to the null model. Overdispersion occurs when the observed variance is greater than the theoretical variance, which is tied to the mean in Poisson models, and this indicates how much the models explain the variance of tobacco outlet density. The higher or lower the chi-square statistic, the more or less data are overdispersed.

Results

According to the 2011-2015 American Community Survey, Maryland had a lower White population percentage than the U.S., 57.07% compared to 73.6%, and higher Black population percentage than the U.S., 31.14% compared to 12.61% (U.S. Census Bureau, 2017). The median household income for Maryland was $77,606, which was higher than the median household income of the United States during the same period – $53,889. Maryland also had a lower income inequality coefficient (0.40 to 0.48), a higher percentage of individuals 25 years and older with at least a Bachelor's degree (36.37% to 29.8%), and a higher labor force participation rate (68.05% to 63.7%) than the United States. The tobacco outlet availability in Maryland was 0.64 outlets per 1,000 persons per Census Tract, and the tobacco outlet access in Maryland was 0.86 outlets per 10km of roadway (see Table 5.1). Moran's I was tested to determine the extent of spatial dependence in the State of Maryland. Consistent with the first two aims the coefficient was conducted with both the number of tobacco outlets and the number of tobacco outlets per 1,000 persons per Census Tract as outcomes, and Maryland exhibited spatial dependence based both on count ($I = 0.40$, $p = 0.001$) and tobacco outlet density ($I = 0.51$, $p = 0.001$). As a result, spatial lag modeling was conducted.

Univariate Models – Tobacco Outlet Availability

In the univariate model for tobacco outlet availability, there was direct relationship between Black population percentage and tobacco outlet availability in both proximal Census

Tracts (exponentiated β = 1.19, p <0.001) and in distal Census Tract neighborhoods (exponentiated β = 1.23, p <0.001). Additionally, there was a direct relationship between income inequality and tobacco outlet availability in both proximal Census Tracts (exponentiated β = 1.09, p <0.001) and in distal Census Tract neighborhoods (exponentiated β = 1.16, p <0.001). The model results showed an inverse relationship between labor force participation rate and tobacco outlet availability in both proximal Census Tracts (exponentiated β = 0.79, p <0.001) and distal Census Tract neighborhoods (exponentiated β = 0.51, p <0.001). Additionally, there was an inverse relationship between the percentage of individuals 25 years and older with at least a Bachelor's degree and tobacco outlet availability in proximal Census Tracts (exponentiated β = 0.80, p <0.001), and there was an inverse relationship between median household income and tobacco outlet availability in distal Census Tract neighborhoods (exponentiated β = 0.73, p <0.001) (see Table 5.2).

Univariate Models – Tobacco Outlet Access

In the univariate model for tobacco outlet access, there was a direct relationship between Black population percentage and tobacco outlet access in both proximal Census Tracts (exponentiated β = 1.29, p <0.001) and in distal Census Tract neighborhoods (exponentiated β = 1.34, p <0.001). Additionally, there was a direct relationship between income inequality and tobacco outlet access in both proximal Census Tracts (exponentiated β = 1.08, p <0.001) and in distal Census Tract neighborhoods (exponentiated β = 1.14, p <0.001). The model results showed an inverse relationship between White population percentage and tobacco outlet access in proximal Census Tracts (exponentiated β = 0.76, p <0.001), and an inverse relationship between labor force participation rate and tobacco outlet access in proximal Census Tracts (exponentiated β = 0.82, p <0.001). Additionally, there was an inverse relationship between labor force

participation rate and tobacco outlet access in distal Census Tract neighborhoods (exponentiated $\beta = 0.73$, $p < 0.001$), followed by inverse relationships between median household income, White population percentage, the percentage of individuals aged 25 years and older with at least a Bachelor's degree, and tobacco outlet access in distal Census Tract neighborhoods (exponentiated $\beta = 0.74$, $p < 0.001$) (see Table 5.3).

Race-Exclusive Models

Race-exclusive models were conducted to examine the adjusted relationships between Black population percentage, White population percentage and tobacco outlet availability and access in proximal Census Tracts only, and in proximal Census Tracts and distal Census Tract neighborhoods. The focal effects-only model results showed that Black population percentage had a direct relationship with tobacco outlet availability (exponentiated $\beta = 1.28$, $p < 0.001$) and tobacco outlet access (exponentiated $\beta = 1.02$, $p < 0.001$) in proximal Census Tracts. Conversely, White population percentage had a direct relationship with tobacco outlet availability (exponentiated $\beta = 1.09$, $p < 0.001$), but had an inverse relationship with tobacco outlet access (exponentiated $\beta = 0.78$, $p < 0.001$) (see Tables 5.4 and 5.5). In the multivariate model for racial effects in both proximal Census Tracts and in distal Census Tract neighborhoods, both Black population percentage and White population percentage had inverse relationships with tobacco outlet availability (exponentiated $\beta = 0.91$, $p < 0.001$ and exponentiated $\beta = 0.96$, $p < 0.001$, respectively) and tobacco outlet access (exponentiated $\beta = 0.85$, $p < 0.001$ and exponentiated $\beta = 0.78$, $p < 0.001$, respectively) in proximal Census Tracts. Conversely, both Black population percentage and White population percentage had direct relationships with tobacco outlet availability (exponentiated $\beta = 1.57$, $p < 0.001$ and exponentiated $\beta = 1.21$, $p < 0.001$, respectively) and tobacco outlet access (exponentiated $\beta = 1.27$, $p < 0.001$ and exponentiated $\beta =$

1.01, p <0.001, respectively) in distal Census Tract neighborhoods. Chi-square statistics showed a reduction in overdispersion between the null model for availability ($\chi 2$ = 13,774,925) and the race-exclusive model for availability ($\chi 2$ = 9,883,941), and a reduction in overdispersion between the null model for access ($\chi 2$ = 225,786,673) and the race-exclusive model for access ($\chi 2$ = 139,446,602).

Socioeconomic Status-Exclusive Models

Socioeconomic status-exclusive models were conducted to examine the adjusted relationships between socioeconomic status measures and tobacco outlet availability and access in proximal Census Tracts only, and in proximal Census Tracts and distal Census Tract neighborhoods. The model results showed that nearly all socioeconomic status measures had consistent relationships with both tobacco outlet availability and tobacco outlet access. The exceptions to consistent relationships were vacant houses in both proximal Census Tracts and in distal Census Tract neighborhoods, and the percentage of individuals aged 25 and older with at least a Bachelor's degree in distal Census Tract neighborhoods.

Notably, there was an inverse relationship between median household income and both tobacco outlet availability (exponentiated β = 0.99, p <0.001 and exponentiated β = 0.84, p <0.001, respectively) and tobacco outlet access (exponentiated β = 0.95, p <0.001 and exponentiated β = 0.76, p <0.001, respectively) in both proximal Census Tracts and in distal Census Tract neighborhoods. Conversely, there was a direct relationship between labor force participation rate and both tobacco outlet availability (exponentiated β = 1.16, p <0.001 and exponentiated β = 1.36, p <0.001, respectively) and tobacco outlet access (exponentiated β = 1.24, p <0.001 and exponentiated β = 2.15, p <0.001, respectively) in both proximal Census Tracts and in distal Census Tract neighborhoods (see Tables 5.6 and 5.7). Chi-square statistics

showed a reduction in overdispersion between the null model for availability ($\chi 2 = 13{,}774{,}925$) and the socioeconomic status-exclusive model for availability ($\chi 2 = 5{,}484{,}326$), and a reduction in overdispersion between the null model for access ($\chi 2 = 225{,}786{,}673$) and the socioeconomic status-exclusive model for access ($\chi 2 = 107{,}900{,}142$).

Full Statewide Models – Tobacco Outlet Availability

In the full statewide model examining sociodemographic factors and tobacco outlet availability in proximal Census tracts, nearly all covariates had a consistent relationship with tobacco outlet availability in both the focal effects-exclusive model and the model with focal effects and spatial lag effects. The exceptions to consistent relationships were Black population percentage and median household income. Notably, there were direct relationships between Black population percentage, labor force participation rate and tobacco outlet availability among proximal Census Tracts (exponentiated $\beta = 1.08$, $p < 0.001$). Conversely, there was an inverse relationship between median household income and tobacco outlet availability in proximal Census Tracts (exponentiated $\beta = 0.91$, $p < 0.001$). In the model with both focal effects and spatial lag effects, there was a direct relationship between labor force participation rate and tobacco outlet availability in distal Census Tract neighborhoods (exponentiated $\beta = 1.29$, $p < 0.001$), and a direct relationship between Black population percentage and tobacco outlet availability in distal Census Tract neighborhoods (exponentiated $\beta = 1.19$, $p < 0.001$). Conversely, there was an inverse relationship between median household income and tobacco outlet availability in distal Census Tract neighborhoods (exponentiated $\beta = 0.88$, $p < 0.001$), and an inverse relationship between Black population percentage and tobacco outlet availability in proximal Census Tracts (exponentiated $\beta = 0.92$, $p < 0.001$) (see Tables 5.8 and 5.9).

Full Statewide Models – Tobacco Outlet Access

In the full statewide model examining sociodemographic factors and tobacco outlet access in proximal Census tracts, nearly all covariates in proximal Census tracts had a consistent relationship with tobacco outlet access between the focal effects-exclusive model and the model with both focal effects and spatial lag effects. The exception to consistent relationships was the percentage of individuals aged 25 and older with at least a Bachelor's degree. Notably, there as a direct relationship between labor force participation rate and tobacco outlet access among proximal Census Tracts (exponentiated $\beta = 1.15$, $p < 0.001$), and a direct relationship between income inequality and tobacco outlet access in proximal Census Tracts (exponentiated $\beta = 1.08$, $p < 0.001$). Additionally, there was an inverse relationship between White population percentage and tobacco outlet access in proximal Census Tracts (exponentiated $\beta = 0.78$, $p < 0.001$), as well as an inverse relationship between Black population percentage, median household income and tobacco outlet access in proximal Census Tracts (exponentiated $\beta = 0.83$, $p < 0.001$). In the model with both focal effects and spatial lag effects, there was a direct relationship between labor force participation rate and tobacco outlet access in both distal Census Tract neighborhoods (exponentiated $\beta = 1.62$, $p < 0.001$) and in proximal Census Tracts (exponentiated $\beta = 1.19$, $p < 0.001$). Conversely, there was an inverse relationship between White population percentage and tobacco outlet access in proximal Census Tracts (exponentiated $\beta = 0.78$, $p < 0.001$), as well as an inverse relationship between Black population percentage and tobacco outlet access in proximal Census Tracts (exponentiated $\beta = 0.83$, $p < 0.001$) (see Tables 5.10 and 5.11).

Full Statewide Models with Interaction Terms

The last models conducted were a full statewide model for tobacco outlet availability and tobacco outlet access with interaction terms between focal effects and spatial lag effects. In the model examining sociodemographic factors and tobacco outlet availability, nearly all covariates

had a consistent relationship with tobacco outlet availability in both proximal Census Tracts and in distal Census Tract neighborhoods. The exceptions to consistent relationships were Black population percentage and median household income. Additionally, only income inequality had an interaction term different than 1. Notably, there was a direct relationship between labor force participation rate and tobacco outlet availability in both distal Census Tract neighborhoods (exponentiated $\beta = 1.41$, $p < 0.001$) and in proximal Census Tracts (exponentiated $\beta = 1.25$, $p < 0.001$). Conversely, there was an inverse relationship between the percentage of individuals aged 25 and older with at least a Bachelor's degree in distal Census Tract neighborhoods (exponentiated $\beta = 0.80$, $p < 0.001$) and in proximal Census Tracts (exponentiated $\beta = 0.81$, $p < 0.001$) (see Tables 5.12 and 5.13). Chi-square statistics showed a reduction in overdispersion between the null model for availability ($\chi 2 = 13{,}774{,}925$) and the full model for availability ($\chi 2 = 4{,}649{,}518$). In the model examining sociodemographic factors and tobacco outlet access, nearly all covariates had a consistent relationship with tobacco outlet access in both proximal Census Tracts and in distal Census Tract neighborhoods. The exceptions to consistent relationships were Black population percentage, median household income and vacant houses. Additionally, only income inequality had an interaction term different than 1. Notably, there was a direct relationship between labor force participation rate and tobacco outlet access in distal Census Tract neighborhoods (exponentiated $\beta = 1.56$, $p < 0.001$), as well as a direct relationship between White population percentage and tobacco outlet access in distal Census Tract neighborhoods (exponentiated $\beta = 1.22$, $p < 0.001$). Conversely, there was an inverse relationship between the percentage of individuals aged 25 and older with at least a Bachelor's degree and tobacco outlet access in proximal Census Tracts (exponentiated $\beta = 0.73$, $p < 0.001$), as well as an inverse relationship between Black population percentage and tobacco outlet access in proximal

Census Tracts (exponentiated $\beta = 0.79$, $p < 0.001$) (see Tables 5.14 and 5.15). Chi-square statistics showed a reduction in overdispersion between the null model for access ($\chi 2 =$ 225,786,673) and the full model for access ($\chi 2 = 5,897,793$).

Discussion

The aim of this study was to provide estimates of the relationships between sociodemographic factors and tobacco outlet availability and access in a racially heterogeneous locale while utilizing recent sociodemographic and tobacco outlet data. The results of this study bear similarity to past statewide and nationwide studies, in that Black population percentage is directly related to tobacco outlet density, White population percentage is inversely related to tobacco outlet density, and that socioeconomic status is inversely related to tobacco outlet density. As an advancement of past studies, the findings not only show that the relationships between race, socioeconomic status and tobacco outlet density apply to both tobacco outlet availability and tobacco outlet access, but that there are multiple measures of socioeconomic status besides median household income that have inverse relationships with tobacco outlet availability and access, such as the percentage of individuals aged 25 years and older with at least a Bachelor's degree. Additionally, there are measures of socioeconomic status that have direct relationships with tobacco outlet availability and access, such income inequality, vacant houses and labor force participation rate. Specifically, the relationship between income inequality and tobacco outlet availability and access support researchers' calls for its inclusion in tobacco outlet density research (Kawachi & Kennedy, 1999; Subramanian & Kawachi, 2004; Fakunle et. al, 2010), and the relationships between vacant housing and tobacco outlet density are consistent with past research (Lee et. al, 2017). The study showed that race, socioeconomic status and the combination of both factors explain a substantial amount of spatial variation in Maryland's tobacco outlet availability and tobacco outlet access, with socioeconomic status

appearing to provide the explain more variation than race. Nevertheless, policymakers should consider both racial and socioeconomic measures when implementing and enforcement tobacco outlet control policies. Specifically, White population percentage, Black population percentage, income inequality and the percentage of individuals aged 25 and older with at least a Bachelor's degree provide reliable relationships with tobacco outlet availability and access. The findings of this study provided additional details that should be considered for future tobacco outlet density research and tobacco reform policies. First, there may be value in considering the relationship with both tobacco outlet availability and tobacco outlet access. The descriptive statistics of Maryland showed that tobacco outlet availability and tobacco outlet access in the state provided different figures. Additionally, the Poisson models showed that while many covariates had consistent relationships with both tobacco outlet availability and tobacco outlet access, the magnitudes showed different values. In some cases, the relationships between sociodemographic factors and tobacco outlet density changed when the outcome was availability as opposed to access, and when the outcome was access as opposed to availability. For example, White population percentage had a direct relationship with tobacco outlet availability in the race-exclusive model for only focal effects, yet had an inverse relationship in the same model for tobacco outlet access. Additionally, Black population percentage in proximal Census Tracts exhibited the same change in direction – direct relationship with availability yet inverse relationship with access – in the full statewide model, while the percentage of individuals aged 25 and older with at least a Bachelor's degree exhibited the opposite switch. Although there is no statistical method to test for differences in coefficients based on two different outcomes (Curriero, 2017), there appears to be value in examining both the availability of tobacco outlets and the access to tobacco outlets to present a more whole view of tobacco outlet density and to

better understand the nuances relating to sociodemographic relationships. Second, it is important to consider tobacco outlet density in immediate and extended neighborhoods. Spatial lag models provide information on relationships in locales beyond the immediate areas of interest, and the results of the models in this study show that the consideration of both proximal Census Tracts and distal Census Tract neighborhoods affect how sociodemographics are related to tobacco outlet availability and tobacco outlet access. Like with tobacco outlet availability and tobacco outlet access, many sociodemographic covariates showed consistent relationships. However, there were exceptions. For example, both Black population percentage and White population percentage had direct relationships with both tobacco outlet availability in the model only proximal Census Tracts. However, when spatial lag effects were included, both Black population percentage and White population percentage in proximal Census Tracts had inverse relationships with tobacco outlet availability. Additionally, in the socioeconomic status-exclusive model, the percentage of individuals aged 25 and older with at least a Bachelor's degree had an inverse relationship with tobacco outlet access in proximal Census Tracts, yet had a direct relationship with tobacco outlet access in distal Census Tract neighborhoods. This may indicate the variability of tobacco outlet availability in neighborhoods, where one neighborhood may have a higher level of availability but the adjacent neighborhoods may have lower levels of availability. The opposite circumstance could also be true, where one neighborhood has a lower level of availability while the adjacent neighborhoods have higher levels of availability. Differences in how neighborhoods interact with each other would not be detected if both focal effects and spatial lag effects are not examined. Therefore, there appears to be value in examining how tobacco outlet availability, tobacco outlet access and their relationships with sociodemographics are influenced by both immediate neighborhoods and surrounding neighborhoods, with the

policy implication being more consistent implementation of tobacco outlet control and enforcement across adjacent neighborhoods in an area and as a result, potentially more effective tobacco control.

Table 5.1: Descriptives of Sociodemographics, Tobacco Outlet Availability and Tobacco Outlet Access in Maryland – 2011-2015

Mean Characteristic Per Census Tract	Maryland (# Tracts = 1,388)
Population (SD)	4,272.21 (1,786.01)
Black Population Percentage (SD)	31.14 (31.16)
White Population Percentage (SD)	57.07 (31.56)
Median Household Income (SD)	$77,606 ($36,763)
Gini Coefficient (SD)	0.40 (0.06)
Percentage of Individuals Aged 25+ with at Least a Bachelor's Degree (SD)	36.37 (20.53)
Labor Force Participation Rate (SD)	68.05 (9.85)
Number of Vacant Houses	175.70 (467.09)
Tobacco Outlets per 1000 (SD)	0.64 (1.39)
Tobacco Outlets per 10km of Roadway (SD)	0.86 (1.82)

Table 5.2: Univariate Spatial Lag Regression Model Coefficients for Sociodemographics on Tobacco Outlet Availability in Maryland – 2011-2015

Covariate	**Focal Effects**		**Spatial Lag Effects**	
	Exponentiated Beta	p-value	Exponentiated Beta	p-value
Black Population Percentage (per 10%)	**1.19**	**<0.001**	**1.23**	**<0.001**
White Population Percentage (per 10%)	**0.85**	**<0.001**	**0.82**	**<0.001**
Median Household Income (per $10000)	**0.82**	**<0.001**	**0.73**	**<0.001**
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**0.80**	**<0.001**	**0.74**	**<0.001**
Labor Force Participation Rate (per 10%)	**0.79**	**<0.001**	**0.51**	**<0.001**
Gini Income Inequality Coefficient (per 1%)	**1.09**	**<0.001**	**1.16**	**<0.001**
Vacant Houses (per 100)	**1.03**	**<0.001**	**1.05**	**<0.001**

Table 5.3: Univariate Spatial Lag Regression Model Coefficients for Sociodemographics on Tobacco Outlet Access in Maryland – 2011-2015

Covariate	**Focal Effects**		**Spatial Lag Effects**	
	Exponentiated Beta	p-value	Exponentiated Beta	p-value
Black Population Percentage (per 10%)	**1.29**	**<0.001**	**1.34**	**<0.001**
White Population Percentage (per 10%)	**0.76**	**<0.001**	**0.74**	**<0.001**
Median Household Income (per $10000)	**0.84**	**<0.001**	**0.74**	**<0.001**
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**0.85**	**<0.001**	**0.74**	**<0.001**
Labor Force Participation Rate (per 10%)	**0.82**	**<0.001**	**0.73**	**<0.001**
Gini Income Inequality Coefficient (per 1%)	**1.08**	**<0.001**	**1.14**	**<0.001**
Vacant Houses (per 100)	**1.01**	**<0.001**	**1.02**	**<0.001**

Table 5.4: Multivariate Spatial Lag Regression Model Coefficients for Race Covariates on Tobacco Outlet Availability in Maryland – 2011-2015

Covariate	Focal Effects		Focal & Spatial Lag	
	Exponentiated Beta	p-value	Exponentiated Beta	p-value
Focal Effects				
Black Population Percentage (per 10%)	**1.28**	**<0.001**	**0.91**	**<0.001**
White Population Percentage (per 10%)	**1.09**	**<0.001**	**0.96**	**<0.001**
Spatial Effects				
Black Population Percentage (per 10%)			**1.57**	**<0.001**
White Population Percentage (per 10%)			**1.21**	**<0.001**

Table 5.5: Multivariate Spatial Lag Regression Model Coefficients for Race Covariates on Tobacco Outlet Access in Maryland – 2011-2015

Covariate	Focal Effects		Focal & Spatial Lag	
	Exponentiated Beta	p-value	Exponentiated Beta	p-value
Focal Effects				
Black Population Percentage (per 10%)	**1.02**	**<0.001**	**0.85**	**<0.001**
White Population Percentage (per 10%)	**0.78**	**<0.001**	**0.78**	**<0.001**
Spatial Effects				
Black Population Percentage (per 10%)			**1.27**	**<0.001**
White Population Percentage (per 10%)			**1.01**	**<0.001**

Table 5.6: Multivariate Spatial Lag Regression Model Coefficients for Socioeconomic Status Covariates on Tobacco Outlet Availability in Maryland – 2011-2015

Covariate	Focal Effects		Focal & Spatial Lag	
	Exponentiated Beta	p-value	Exponentiated Beta	p-value
Focal Effects				
Median Household Income (per $10000)	**0.89**	**<0.001**	**0.99**	**<0.001**
Gini Income Inequality Coefficient (per 1%)	**1.08**	**<0.001**	**1.05**	**<0.001**
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**0.91**	**<0.001**	**0.99**	**<0.001**
Labor Force Participation Rate (per 10%)	**1.10**	**<0.001**	**1.16**	**<0.001**
Vacant Houses (per 100)	**1.02**	**<0.001**	**1.01**	
Spatial Effects				
Median Household Income (per $10000)			**0.84**	**<0.001**
Gini Income Inequality Coefficient (per 1%)			**1.10**	**<0.001**
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)			**0.89**	**<0.001**
Labor Force Participation Rate (per 10%)			**1.36**	**<0.001**
Vacant Houses (per 100)			**1.00**	**<0.001**

Table 5.7: Multivariate Spatial Lag Regression Model Coefficients for Socioeconomic Status Covariates on Tobacco Outlet Access in Maryland – 2011-2015

Covariate	Focal Effects		Focal & Spatial Lag	
	Exponentiated Beta	p-value	Exponentiated Beta	p-value
Focal Effects				
Median Household Income (per $10000)	**0.87**	**<0.001**	**0.95**	**<0.001**
Gini Income Inequality Coefficient (per 1%)	**1.08**	**<0.001**	**1.05**	**<0.001**
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**0.97**	**<0.001**	**0.95**	**<0.001**
Labor Force Participation Rate (per 10%)	**1.27**	**<0.001**	**1.24**	**<0.001**
Vacant Houses (per 100)	**1.00**	**<0.001**	**1.01**	**<0.001**
Spatial Effects				
Median Household Income (per $10000)			**0.76**	**<0.001**
Gini Income Inequality Coefficient (per 1%)			**1.10**	**<0.001**
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)			**1.09**	**<0.001**
Labor Force Participation Rate (per 10%)			**2.15**	**<0.001**
Vacant Houses (per 100)			**0.96**	**<0.001**

Table 5.8: Multivariate Spatial Lag Regression Model Coefficients for Sociodemographics on Tobacco Outlet Availability in Maryland (Focal Effects) – 2011-2015

Covariate	Focal Effects		Focal & Spatial Lag	
	Exponentiated Beta	p-value	Exponentiated Beta	p-value
Black Population Percentage (per 10%)	**1.08**	**<0.001**	**0.92**	**<0.001**
White Population Percentage (per 10%)	**0.96**	**<0.001**	**0.97**	**<0.001**
Median Household Income (per $10000)	**0.91**	**<0.001**	**1.00**	**<0.001**
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**0.98**	**<0.001**	**0.99**	**<0.001**
Labor Force Participation Rate (per 10%)	**1.08**	**<0.001**	**1.14**	**<0.001**
Gini Income Inequality Coefficient (per 1%)	**1.07**	**<0.001**	**1.05**	**<0.001**
Vacant Houses (per 100)	**1.02**	**<0.001**	**1.01**	**<0.001**

Table 5.9: Multivariate Spatial Lag Regression Model Coefficients for Sociodemographics on Tobacco Outlet Availability in Maryland (Spatial Lag Effects) – 2011-2015

Covariate	**Focal & Spatial Lag**	
	Exponentiated Beta	p-value
Black Population Percentage (per 10%)	**1.19**	**<0.001**
White Population Percentage (per 10%)	**0.99**	**<0.001**
Median Household Income (per $10000)	**0.88**	**<0.001**
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**0.96**	**<0.001**
Labor Force Participation Rate (per 10%)	**1.29**	**<0.001**
Gini Income Inequality Coefficient (per 1%)	**1.09**	**<0.001**
Vacant Houses (per 100)	**1.02**	**<0.001**

Table 5.10: Multivariate Spatial Lag Regression Model Coefficients for Sociodemographics on Tobacco Outlet Access in Maryland (Focal Effects) – 2011-2015

Covariate	**Focal Effects**		**Focal & Spatial Lag**	
	Exponentiated Beta	p-value	Exponentiated Beta	p-value
Black Population Percentage (per 10%)	**0.90**	**<0.001**	**0.83**	**<0.001**
White Population Percentage (per 10%)	**0.69**	**<0.001**	**0.78**	**<0.001**
Median Household Income (per $10000)	**0.90**	**<0.001**	**0.98**	**<0.001**
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**1.07**	**<0.001**	**1.00**	**<0.001**
Labor Force Participation Rate (per 10%)	**1.15**	**<0.001**	**1.19**	**<0.001**
Gini Income Inequality Coefficient (per 1%)	**1.08**	**<0.001**	**1.05**	**<0.001**
Vacant Houses (per 100)	**1.02**	**<0.001**	**1.02**	**<0.001**

Table 5.11: Multivariate Spatial Lag Regression Model Coefficients for Sociodemographics on Tobacco Outlet Access in Maryland (Spatial Lag Effects) – 2011-2015

Covariate	**Focal & Spatial Lag**	
	Exponentiated Beta	p-value
Black Population Percentage (per 10%)	**1.10**	**<0.001**
White Population Percentage (per 10%)	**0.89**	**<0.001**
Median Household Income (per $10000)	**0.85**	**<0.001**
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**1.11**	**<0.001**
Labor Force Participation Rate (per 10%)	**1.62**	**<0.001**
Gini Income Inequality Coefficient (per 1%)	**1.10**	**<0.001**
Vacant Houses (per 100)	1.00	0.90

Table 5.12: Multivariate Spatial Lag Covariate Interaction Regression Model Coefficients for Sociodemographics on Tobacco Outlet Availability in Maryland (Focal Effects) – 2011-2015

Covariate	Focal & Spatial Lag		Focal & Spatial Lag Interaction	
	Exponentiated Beta	p-value	Exponentiated Beta	p-value
Black Population Percentage (per 10%)	**0.92**	**<0.001**	**1.00**	**<0.001**
White Population Percentage (per 10%)	**1.15**	**<0.001**	**1.00**	**<0.001**
Median Household Income (per $10000)	**1.03**	**<0.001**	**1.00**	**<0.001**
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**0.81**	**<0.001**	**1.00**	**<0.001**
Labor Force Participation Rate (per 10%)	**1.25**	**<0.001**	**1.00**	**<0.001**
Gini Income Inequality Coefficient (per 1%)	**1.01**	**<0.001**	**1.09**	**<0.001**
Vacant Houses (per 100)	**1.02**	**<0.001**	**1.00**	**<0.001**

Table 5.13: Multivariate Spatial Lag Covariate Interaction Regression Model Coefficients for Sociodemographics on Tobacco Outlet Availability in Maryland (Spatial Lag Effects) – 2011-2015

Covariate	**Focal & Spatial Lag**	
	Exponentiated Beta	p-value
Black Population Percentage (per 10%)	**1.16**	**<0.001**
White Population Percentage (per 10%)	**1.17**	**<0.001**
Median Household Income (per $10000)	**0.90**	**<0.001**
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**0.80**	**<0.001**
Labor Force Participation Rate (per 10%)	**1.41**	**<0.001**
Gini Income Inequality Coefficient (per 1%)	**1.04**	**<0.001**
Vacant Houses (per 100)	**1.03**	**<0.001**

Table 5.14: Multivariate Spatial Lag Covariate Interaction Regression Model Coefficients for Sociodemographics on Tobacco Outlet Access in Maryland (Focal Effects) – 2011-2015

Covariate	Focal & Spatial Lag		Focal & Spatial Lag Interaction	
	Exponentiated Beta	p-value	Exponentiated Beta	p-value
Black Population Percentage (per 10%)	**0.79**	**<0.001**	**1.00**	**<0.001**
White Population Percentage (per 10%)	**1.08**	**<0.001**	**1.00**	**<0.001**
Median Household Income (per $10000)	**1.01**	**<0.001**	**1.00**	**<0.001**
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**0.73**	**<0.001**	**1.00**	**<0.001**
Labor Force Participation Rate (per 10%)	**1.11**	**<0.001**	**1.00**	**<0.001**
Gini Income Inequality Coefficient (per 1%)	**0.95**	**<0.001**	**1.26**	**<0.001**
Vacant Houses (per 100)	**1.01**	**<0.001**	**1.00**	**<0.001**

Table 5.15: Multivariate Spatial Lag Covariate Interaction Regression Model Coefficients for Sociodemographics on Tobacco Outlet Access in Maryland (Spatial Lag Effects) – 2011-2015

Covariate	**Focal & Spatial Lag**	
	Exponentiated Beta	p-value
Black Population Percentage (per 10%)	**1.01**	**<0.001**
White Population Percentage (per 10%)	**1.22**	**<0.001**
Median Household Income (per $10000)	**0.86**	**<0.001**
Percentage of Individuals 25+ with at least a Bachelor's Degree (per 10%)	**0.80**	**<0.001**
Labor Force Participation Rate (per 10%)	**1.56**	**<0.001**
Gini Income Inequality Coefficient (per 1%)	**0.99**	**<0.001**
Vacant Houses (per 100)	**1.00**	**<0.001**

Chapter 6: Discussion

The overall goal of this study was to elucidate the relationship between race, socioeconomic status, and tobacco outlet density, thereby refining the basic epidemiological foundation of social determinants of tobacco availability and access and providing concrete support for proactive tobacco outlet control and enforcement. Through the three aims, this study provided robust empirical evidence showing the various relationships that connect the contextual interaction of race and socioeconomic status to tobacco outlet density. The evidence of relationships can facilitate and support policies that reduce the disadvantage created by inequitable tobacco availability and access, while pushing tobacco researchers towards nuanced understandings of the causal factors of differences in tobacco outlet density. The hypotheses of Aim I and Aim II were both based on the idea that socioeconomic status influenced the availability and access of tobacco outlets more than race, an idea first proposed by Fakunle and colleagues in 2010 and then refined by Fakunle and colleagues in 2016. The results of Aim I, an increase in knowledge from Fakunle et. al (2016), supported the hypothesis and showed that there was an inverse relationship between socioeconomic status and tobacco outlet density in predominantly-White Maryland jurisdictions. More so, the results suggested that median household income, often the only measure of socioeconomic status in tobacco outlet density studies, is the most consistent predictor of tobacco outlet density among various socioeconomic metrics including education, participation in the labor force and income inequality. The implication is that inequitable distributions of tobacco outlets fall along socioeconomic gradients regardless of race, and that tobacco control policies should be sensitive to the socioeconomic status of neighborhoods, of which median household income is a reliable measure to consider. Aim II built on the concept and methodology of Aim I first by continuing to examine if

socioeconomic status exhibited more influence on tobacco outlet density by comparing racially divergent Maryland locales with similar socioeconomic status, and second by utilizing both a measure of tobacco outlet availability and a measure of tobacco outlet access to acknowledge potential differences in the more suburban and rural predominantly White locales compared to the more urban predominantly Black locales. The results of Aim II did not support the hypothesis that racially divergent-yet socioeconomically similar locales would have similar tobacco outlet availability and access. Rather, the results consistently showed that predominantly Black locales had greater tobacco outlet availability and tobacco outlet access than their predominantly-White counterparts. The results modify the implications of Aim I but suggesting that while there are socioeconomic gradients associated with tobacco outlet density within racial groups, there are also racial gradients associated with tobacco outlet density. Specifically, predominantly-Black areas have greater availability and access to tobacco outlets than predominantly-White areas despite both areas having similar socioeconomic status. The implication is that tobacco control policy should be sensitive to socioeconomic status and the racial composition of areas when addressing the regulation of tobacco outlets. Aim III utilized the ecological-contextual racial heterogeneity of Maryland to examine the relationships between sociodemographics and statewide tobacco outlet availability and access, and sought add knowledge presented by past statewide and nationwide studies (Reid et. al, 2005; Peterson et. al, 2005; Peterson et. al, 2011; Reid et. al, 2013; Loomis et. al, 2013; Rodriguez et. al, 2012; Lee et. al, 2017), while improving on the methodology by utilizing recent sociodemographic data, recent tobacco outlet data and a measure of both tobacco outlet availability and tobacco outlet access, in addition to the spatial statistics utilized in Aims I and II. The results of the study were consistent with the findings of the past statewide and nationwide studies, showing consistent direct relationships between Black

population percentage, income inequality, vacant houses, labor force participation rate and tobacco outlet density and access, and consistent inverse relationships between median household income, White population percentage, education and tobacco outlet availability and access. Additionally, the statewide study illustrated the importance of examining both tobacco outlet availability and tobacco outlet access, as well as the importance of examining the influence of sociodemographics on tobacco outlet density in proximal Census Tracts and distal Census Tract neighborhoods.

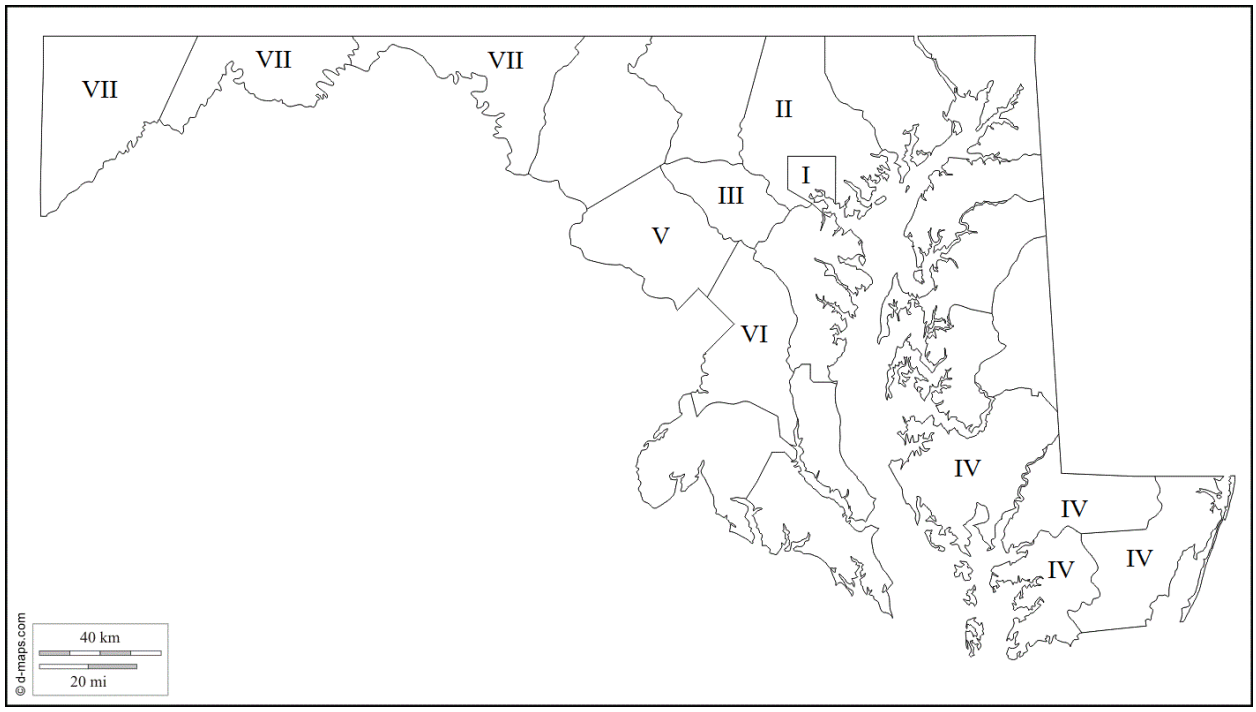
In providing more understanding as to how race and socioeconomic status are associated with tobacco outlet density, this dissertation also showed that the relationship between race, socioeconomic status and the availability and access to tobacco outlets is complex. While the study aims revealed some consistent patterns and relationships, those patterns and relationships were not constant, and despite the expansion of covariates in the analyses such as those for socioeconomic status this study in no way captures the totality of factors that affect tobacco outlet density. That said, this study did not capture the totality of factors that affect tobacco outlet density but rather continue to validate and elaborate on the influence of two primary determinants of resource inequities and health disparities, race and socioeconomic status, which can be used to make equitable public health policy decisions (Evans et. al, 2007; Boardman et. al, 2001; Morello-Frosch et. al, 2006). The expectancy is that future tobacco outlet density research will use this dissertation as a footing to investigate other relationships with tobacco outlet density like non-White and non-Black racial groups, the influence of wealth, and whether inequalities in tobacco outlet availability and access are similar or different than inequalities in alcohol outlets or fast-food establishments (LaVeist & Wallace, 2000; Walker et. al, 2010). Additionally, the expectancy is that future tobacco outlet density research utilizes measures for

tobacco outlet availability and tobacco outlet access that are appropriate for the study areas, and considers both the immediate study area and extended study area. It was previously mentioned in this dissertation that research has shown the direct relationship between tobacco outlet density and tobacco use (Novak et. al, 2006; Henriksen et. al, 2008; Cantrell et. al, 2015; Lipperman-Kreda et. al, 2012; McCarthy et. al, 2009). Additionally, recent studies have shown that proactive measures to reduce tobacco outlet density correlate with reductions in use, such as Polinski and colleagues (2017) who reported significant decreases in household-level and population-level purchasing of tobacco products in 13 states where CVS Pharmacy decided to discontinue tobacco sales. Given the results of this dissertation and the knowledge that tobacco outlet availability and access directly correlate with tobacco use, this author implores that efforts to reduce tobacco inequalities and tobacco-related health disparities are done with the lens of racial and socioeconomic disparities. Rbisl and colleagues (2016) estimated that a ban on tobacco sales within 1,000 feet of schools in New York and Missouri would reduce or eliminate disproportions in tobacco outlet availability and access. Similar measures could be implemented in Maryland, a state that has a tobacco outlet licensing system yet has very limited zoning regulations for tobacco outlets (see Appendices B and C). The presence of statewide tobacco outlet licensing system can allow for the implementation of policies such as those recommended by Ashe and colleagues (2003) like limiting the number of outlets in areas that have a sufficient availability and access to tobacco products and limiting the proximity of tobacco outlets to each other. Major cities like Philadelphia, which previously did not have a local tobacco licensing system, are now utilizing licensing to curb the disproportion of tobacco outlets to all citizens (Philadelphia Department of Public Health, 2009). Like San Francisco, local and state municipalities can utilize licensing and enforce equitable distributions of tobacco outlets by deciding the

appropriate number of outlets in a neighborhood or district. That decision would be informed in part by the racial concentration and socioeconomic status of neighborhoods and districts, and measures like Black population percentage, White population percentage, median household income, income inequality and vacant housing can serve as reliable guidelines for limiting tobacco outlet availability and access. Because regulation of tobacco outlet density remains relatively uncharted territory, there is a lot of room for ingenuity as how best to control tobacco availability and access. However, that ingenuity would be best served while operating with the knowledge that both racial and socioeconomic gradients are associated with tobacco outlet density, and that lower-income, non-White communities are most affected by inequitable distributions of tobacco outlets (see Appendix D). The knowledge of racial and socioeconomic disparities (LaVeist, 2005; LaVeist et. al, 2011; Williams & Collins, 2001; Williams et. al, 2010), coupled with knowledge of tobacco-related outcomes can assure a powerful argument in favor of proactive regulation to strengthen public health (Ashe et. al, 2003).

Tobacco outlet density is an evolving field in drug epidemiology that will benefit from core principles. One is that greater density is associated with more use, and this dissertation provides evidence to elaborate on the relationships between sociodemographics and tobacco outlet density. So, regarding the question of "Black, White, or Green?" This dissertation concludes that the answer is "Black, White, **and** Green."

Appendix A: Geographical Map of Study Areas



I – Baltimore City, Maryland

II – Baltimore County, Maryland

III – Howard County, Maryland

IV – Lower Eastern Shore, Maryland (Dorchester County, Somerset County, Wicomico County and Worcester County)

V – Montgomery County, Maryland

VI – Prince George's County, Maryland

VII – Western Maryland (Allegany County, Garrett County and Washington County)

Appendix B: Tobacco Licenses in Maryland

Per the Maryland Business Regulation, licenses to sell tobacco products are administered through the Clerks of the Circuit Courts of Maryland's 23 counties and Baltimore City, on behalf of the Comptroller of Maryland.[63] Tobacco licenses in Maryland consist of several components:

1. Cigarette: retail sales of cigarettes from a store or fixed location (not a machine)
2. Special Retail Cigarette: state fee for retail sales of cigarettes over-the-counter; issued in conjunction with cigarette license
3. Other Tobacco Products (OTP): any cigar or roll for smoking, other than a cigarette, made in whole or in part of tobacco; or any other tobacco or product made primarily from tobacco, other than a cigarette, that is intended for consumption by smoking or chewing or as snuff
4. Tobacconist: an OTP business that derives at least 70% of its revenues, measured by average daily receipts, from the sale of OTP and tobacco-related accessories

Within the Maryland Business Regulation, Title 16 (Cigarettes) and Title 16.5 (Other Tobacco Products Licenses), there exists no language that provides framework or restrictions on retailer locations as a condition for license issuance. With the titles, the primary requirement for license issuance is to complete the application, submit to the Clerk of the Circuit Court of the appropriate jurisdiction, and pay the application fee. Therefore, any business establishment issued any combination of tobacco licenses in the state of Maryland is considered a tobacco outlet.

Appendix C: Tobacco Outlet Zoning in Maryland

The zoning of all establishments – including business retailers – is outlined in the regulations or codes of each Maryland jurisdiction. For this dissertation, the zoning regulations and jurisdiction codes for Baltimore City, Baltimore County, Montgomery County, and Prince George's County were reviewed. The review found no language that provided guidelines for the physical location of tobacco outlets except for the Prince George's County Code of Ordinances (Subtitle 27: Zoning), which contains guidelines for the zoning of tobacco shops and electronic cigarette shops. These retailers are more defined by their tobacconist licenses, meaning the majority (at least 70%) of their sales derive from tobacco products:

> Sec. 27-415.01. - Tobacco shops or electronic cigarette shops.
>
> (a) Tobacco shops or electronic cigarette shops may be permitted by Special Exception, subject to the following:
>
> (1) The structure in which the use is proposed shall be located at least three hundred (300) feet from any school, library, park, recreational facility, and historic site, resource, or district identified on any applicable Historic Site and District Plan, a National Register Site, or an Historic District.
>
> (2) In its final decision to approve a Special Exception for the use, the Council may impose other reasonable requirements deemed necessary to safeguard the health, safety, morals, and general welfare of the community, taking into account the character of surrounding properties and the general neighborhood, and any other uses on the subject property.
>
> (3)No Special Exception shall be permitted for a tobacco shop or electronic cigarette shop located within 2,000 feet of another tobacco shop or electronic cigarette shop.

Appendix D: The Mere-Exposure Effect

The mere-exposure effect, also known as the familiarity principle, is a phenomenon within social psychology which states that people who are exposed to an object with enough regularity will develop a preference for that object. Robert Zajonc (2001) in his research of the phenomenon stated that initial exposure may cause reaction based on fear, but after repeated exposure the reaction becomes one of familiarity and ultimately attachment.

It is posited that greater tobacco outlet density – which has essentially replaced traditional advertising due to jurisdictional policy restrictions – is associated with higher tobacco use via the mere-exposure effect.

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Ward, E., Jemal, A., Cokkinides, V., Singh, G. K., Cardinez, C., Ghafoor, A., & Thun, M. (2004). Cancer disparities by race/ethnicity and socioeconomic status. *CA: a cancer journal for clinicians*, *54*(2), 78-93.

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Williams, D. R., & Collins, C. (2001). Racial residential segregation: a fundamental cause of racial disparities in health. *Public health reports,* 116(5), 404-416.

Williams, D. R. (1997). Race and health: basic questions, emerging directions. *Annals of epidemiology,* 7(5), 322-333.

Williams, D. R., Lavizzo-Mourey, R., & Warren, R. C. (1994). The concept of race and health status in America. *Public health reports,* 109(1), 26.

Williams, D. R., Mohammed, S. A., Leavell, J., & Collins, C. (2010). Race, socioeconomic status, and health: complexities, ongoing challenges, and research opportunities. *Annals of the New York academy of sciences*, *1186*(1), 69-101.

Williams, D. R., & Williams-Morris, R. (2000). Racism and mental health: The African American experience. *Ethnicity and health*, *5*(3-4), 243-268.

Yu, D., Peterson, N. A., & Reid, R. J. (2009). Exploring the impact of non-normality on spatial non-stationarity in geographically weighted regression analyses: Tobacco outlet density in New Jersey. *GIScience & remote sensing*, *46*(3), 329-346.

Yu, D., Peterson, N. A., Sheffer, M. A., Reid, R. J., & Schnieder, J. E. (2010). Tobacco outlet density and demographics: analysing the relationships with a spatial regression approach. *Public health*, *124*(7), 412-416.

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Zhu, L., Gorman, D. M., & Horel, S. (2004). Alcohol outlet density and violence: a geospatial analysis. *Alcohol and alcoholism*, *39*(4), 369-375.

Curriculum Vitae

October 2017

CURRICULUM VITAE

David O. Fakunle

PERSONAL INFORMATION

Johns Hopkins University, Bloomberg School of Public Health • Department of Mental Health

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NIH e-commons username: dfakunle

EDUCATION

2017 **PhD** **The Johns Hopkins University • Bloomberg School of Public Health** Department of Mental Health; Baltimore, MD
Doctoral Thesis: Black, White, or Green? The Effects of Racial Composition and Socioeconomic Status on Neighborhood-Level Tobacco Outlet Density in Maryland
Advisors: Philip Leaf, PhD (2017); Renee M. Johnson, PhD (2016-2017); Debra Furr-Holden, PhD (2013- 2016)

2009 **BA** **University of Maryland, College Park** Department of Psychology & Department of Criminology and Criminal Justice; College Park, MD

PROFESSIONAL EXPERIENCE

3/17 – **Storytelling Workshop Facilitator.** Red Bull Amaphiko; Baltimore, MD

12/16 – 02/17 **Thread Volunteer Training Facilitator.** Thread's Circle Unbroken Project (TCUP); Baltimore, MD

8/16 – 05/17 **Policy, Community Engagement and Outreach Fellow.** Baltimore City Health Department via Baltimore Corps; Baltimore, MD

6/16 – **Project Coordinator.** Kaiser Permanente Social Innovation Challenge; Baltimore, MD

2/15 – **Staff Member.** Office of Delegate Dan K. Morhaim, District 11, General Assembly of Maryland; Annapolis, MD

12/13 – **Applied Narrative Epidemiologist.** DiscoverME/RecoverME; Baltimore Maryland

9/13 – **Research Associate.** Johns Hopkins University, Bloomberg School of Public Health, Departments of Mental Health and Health, Behavior & Society; Baltimore, MD

6/10 – 8/13 **Social Insurance Specialist.** U.S. Social Security Administration, Office of Disability Operations; Woodlawn, MD

7/09 – 4/10 **Research Analyst.** Fors Marsh Group; Arlington, VA

PROFESSIONAL ACTIVITIES

Organization Membership and Leadership

2017 – Board President, WombWork Productions

2016 – Board Member, Friends School of Baltimore Alumni Association

- Co-Chair – Community Service Sub-Committee (2016-present)

2016 – Member, Access to Wholistic and Productive Living Institute, Inc.

- Board of Directors (2016-present)

2015 – Steering Committee Member, Light City Baltimore

- Labs@Light City Curator (2017-present)
- Community Engagement Subcommittee (2015-2016)
- LightCityU Subcommittee (2015-2016)

2015 – Board Member, African American Leadership Forum for Public Safety

2014 –2017 Member in Training, The College on Problems of Drug Dependence

- Member In Training Committee (MITCo) (2014-2017)

EDITORIAL ACTIVITIES

Peer Review Activities – Ad Hoc Reviewer of Manuscripts, Since 2014

Journal of Epidemiology & Community Health • Journal of Neurosciences in Rural Practice • Net Journal of Social Sciences • Nicotine & Tobacco Research • PLOS One

HONORS AND AWARDS

2018 Selectee – Marquis Who's Who in America

2017 Delegate – American Express Leadership Academy Alumni Summit

2016 Emerging Nonprofit Leader – American Express Leadership Academy 2.0 at the Aspen Institute

2016 Delegate – Centers for Disease Control and Prevention Millennial Health Leaders Summit

2015 Young Cultural Innovator – Salzburg Global Seminar

2014 Second Place – Dr. Donald O. Fedder Graduate Student Poster Competition, Maryland Public Health Association Annual Meeting

2009 Dean's List (Spring) – University of Maryland, College Park

2008 Dean's List (Fall) – University of Maryland, College Park

2008 Completion of National Institute of Mental Health Research Internship

2008 President's List (Spring) – University of Maryland, College Park

2007 Dean's List (Fall) – University of Maryland, College Park

2007 Ida G. and L. Leonard Ruben Scholarship

2007 Maryland State Senatorial Scholarship

2005 East Baltimore Community Corporation College Scholarship

PUBLICATIONS

Journal Articles (peer-reviewed)

1. **Fakunle DO**, Milam AJ, Furr-Holden CDM, Butler III J, Thorpe RJ Jr., LaVeist TA. The inequitable distribution of tobacco outlet density: The role of income in two black Mid-Atlantic geopolitical areas. Public Health. 2016;136:35-40. doi: 10.1016/j.puhe.2016.02.032.
2. Furr-Holden CD, Milam AJ, Nesoff ED, Johnson RM, **Fakunle DO**, Jennings JM, Thorpe RJ Jr. Not in My Back Yard: A Comparative Analysis of Crime Around Publicly Funded Drug Treatment Centers, Liquor Stores, Convenience Stores, and Corner Stores in One Mid-Atlantic City. J Stud Alcohol Drugs. 2016;77(1):17-24. http://dx.doi.org/10.15288/jsad.2016.77.17.
3. Smiley C, **Fakunle DO.** From "brute" to "thug:" The demonization and criminalization of unarmed Black male victims in America. J Hum Behav Soc Environ. 2016;26(3-4):350-366. doi: 10.1080/10911359.2015.1129256.
4. Kinlock BL, Thorpe RJ, Howard D, Bowie JV, Ross LE, **Fakunle DO**, LaVeist TA. Racial disparity in the time between being diagnosed and initial treatment of prostate cancer. Cancer Control. 2016;23(1):47-51.
5. **Fakunle DO**. E-cigarettes in Baltimore alcohol outlets: Geographic and demographic correlates of availability. Drug Alcohol Depend. 2015;156:e65–e66. doi:10.1016/j.drugalcdep.2015.07.1097.
6. Acheampong A, Striley CW, **Fakunle DO**, Cottler L. Sex, drugs, and violence: An analysis of women in drug court. Drug Alcohol Depend. 2015;156:e2–e3. doi:10.1016/j.drugalcdep.2015.07.925.
7. **Fakunle DO**, Milam AJ, Furr-Holden CD. Income variability by race in tobacco outlet density in Maryland. Drug and Alcohol Dependence. 2015;(146): e274. doi: 10.1016/j.drugalcdep.2014.09.211.
8. **Fakunle D**, Morton CM, Peterson NA. The importance of income in the link between tobacco outlet density and demographics at the tract level of analysis in New Jersey. J Ethn Subst Abuse. 2010;9(4):249-59. doi: 10.1080/15332640.2010.522890.

Books, Chapters, Monographs, and Additional Non-Peer Reviewed Contributions

1. **Fakunle DO**, Smiley C, Gomez M. The Black President & the Black Body: The Intersection of Race, Class, Gender, and Violence in America. In Walker LJ, Brooks FE, Goings RB, Eds. *How the Obama Presidency Changed the Political Landscape.* (**2017**). Submitted.

PRACTICE ACTIVITIES

Presentations to Practitioners and Other Stakeholders

Panelist. "Racism and policing." 5th Annual Provost-UHI Symposium on the Social Determinants of Health: "Race, Racism, and Baltimore's Future: A Focus on Structural and Institutional Racism," Baltimore, MD; April 25, **2016.**

Presenter. "Black and blue: Understanding the relationship between police violence and African Americans" – Department of Mental Health Wednesday Noon Centennial Year Seminar Series, Johns Hopkins Bloomberg School of Public Health, Baltimore, MD; November 4, **2015.**

Presenter. "From 'brute' to 'thug': The demonization and criminalization of unarmed Black male victims in America" – 2015 Black Doctoral Network Conference, Atlanta, GA; October 9, **2015.**

Panelist. "Public mental health practice in Baltimore City" – Department of Mental Health Wednesday Noon Centennial Year Seminar Series, Johns Hopkins Bloomberg School of Public Health, Baltimore, MD; October 8, **2015.**

Presenter. "The Inequitable Distribution of Tobacco Outlets in Maryland: Race or Income?" – Maryland Department of Health and Mental Hygiene, Baltimore, MD; January 7, **2015.**

Presenter. "The Inequitable Distribution of Tobacco Outlets in Maryland: Race or Income?" – 2nd Annual Black Doctoral Network Conference, Philadelphia, PA; October 24, **2014.**

Newspaper Articles, Podcasts, and Videos

Fakunle, D.O. (2015, September 18) Inefficiencies contribute to SSA's problems (The Baltimore Sun). Retrieved from http://www.baltimoresun.com/news/opinion/oped/bs-ed-social-security-20150920-story.html

Online Articles

Smiley C, **Fakunle D**. (2016, October 13). Brute to thug: This is why language matters (Huffington Post) [Web log post]. Retrieved from http://www.huffingtonpost.com/entry/brute-to-thug-this-is-why-language-matters_us_57ff9176e4b06f314afeaeb5?gv0wgal4mpfogvi

Fakunle, D. O. (2014, May 21). Communities of color and mental health (Robert Wood Johnson Foundation) [Web log post]. Retrieved from http://www.rwjf.org/en/blogs/human-capital-blog/2014/05/communities_of_color.html

CURRICULUM VITAE

David O. Fakunle
PART II

TEACHING

1. Classroom Instruction/Assistance

Year	Course/Description	Enrollment
2015-2017	**Seminar on public health and well-being in Baltimore** Department of Public Health Studies, Krieger School of Arts & Sciences, Johns Hopkins University (AS.280.320)	28-35
	Lectures on public health and well-being in Baltimore Department of Public Health Studies, Krieger School of Arts & Sciences, Johns Hopkins University (AS.280.120)	115-122
2015	**Seminar in health disparities** Johns Hopkins Bloomberg School of Public Health, Dept. of Health Policy & Management (301.615.01)	38
2015	**Psychopathology for public health** Johns Hopkins Bloomberg School of Public Health, Dept. of Mental Health (330.617.01)	56
2015	**Cultural factor of public health** Department of Public Health Studies, Krieger School of Arts & Sciences, Johns Hopkins University (AS.280.375)	83
2014-2015	**Practical politics, policy and public health** Johns Hopkins Bloomberg School of Public Health, Dept. of Health Policy & Management (318.640.01)	13-21

2. Guest Lectures in Courses

Date	Course/Description, Title of Lecture, and School/Department
Sep. 2015	The Public Health Crisis in Africa, AS.362.371 (Prof. C. Furr-Holden). Johns Hopkins University, Krieger School of Arts and Sciences, Center for Africana Studies
Oct. 2014	Community Based Learning - Advanced Practicum in Community Health, AS.280.530 (Prof. L. Bone). **"Environmental solutions to improve health in Baltimore"** Johns Hopkins University, Krieger School of Arts and Sciences, Department of Public Health Studies

3. *Training Grant Participation*

2013 - 2017	Pre-Doctoral Fellow, Drug Dependence Epidemiology Training Program Johns Hopkins Bloomberg School of Public Health, Dept. of Mental Health

GRANT PARTICIPATION

1. Primary Facilitator

Title	Agency	Budget Amount
"Baltimore's Emotional Emancipation Arts Initiative" (10/15-8/16)	UHI	$5,000

PRESENTATIONS

Scientific Meetings

1. **Fakunle DO,** Eck R, Milam AJ, Thorpe RJ Jr., Furr-Holden CDM. E-cigarettes in Baltimore alcohol outlets: Geographic and demographic correlates of availability. Poster presentation at the *39th Annual Research Society on Alcoholism Scientific Meeting,* New Orleans, LA; June 25-29, 2016
2. **Fakunle DO**. E-cigarettes in Baltimore alcohol outlets: Geographic and demographic correlates of availability. Poster presentation at the *77th Annual Meeting of the College on Problems of Drug Dependence,* Phoenix, AZ; June 13-18, 2015
3. **Fakunle DO**, Milam AJ, Furr-Holden CDM, Butler III J, Thorpe RJ Jr., LaVeist TA. The inequitable distribution of tobacco outlets in Maryland: Race or income?" Platform presentation at the *38th Annual National Conference of the Association for Medical Education and Research in Substance Abuse*, San Francisco, CA; November 6-8, 2014
4. **Fakunle DO**, Milam AJ, Furr-Holden CDM, Butler III J, Thorpe RJ Jr., LaVeist TA. The inequitable distribution of tobacco outlets in Maryland: Race or income?" Poster presentation at the *2014 Maryland Public Health Association Annual Meeting,* Baltimore, MD; September 18, 2014
5. **Fakunle DO**, Milam AJ, Furr-Holden CDM, Butler III J, Thorpe RJ Jr., LaVeist TA. The inequitable distribution of tobacco outlets in Maryland: Race or income?" Poster presentation at the *77th Annual Meeting of the College on Problems of Drug Dependence,* San Juan, PR; June 14-19, 2014
6. **Fakunle D**, Morton CM, Peterson NA. The importance of income in the link between tobacco outlet density and demographics at the tract level of analysis in New Jersey. Poster presentations at the *5th Annual Aresty Research Center Undergraduate Research Symposium,* New Brunswick, NJ; April 24, 2009

ADDITIONAL INFORMATION

Areas of Expertise: Neighborhood-level context, urban health, substance use, social justice, arts and culture, racism, health disparities, mental health